

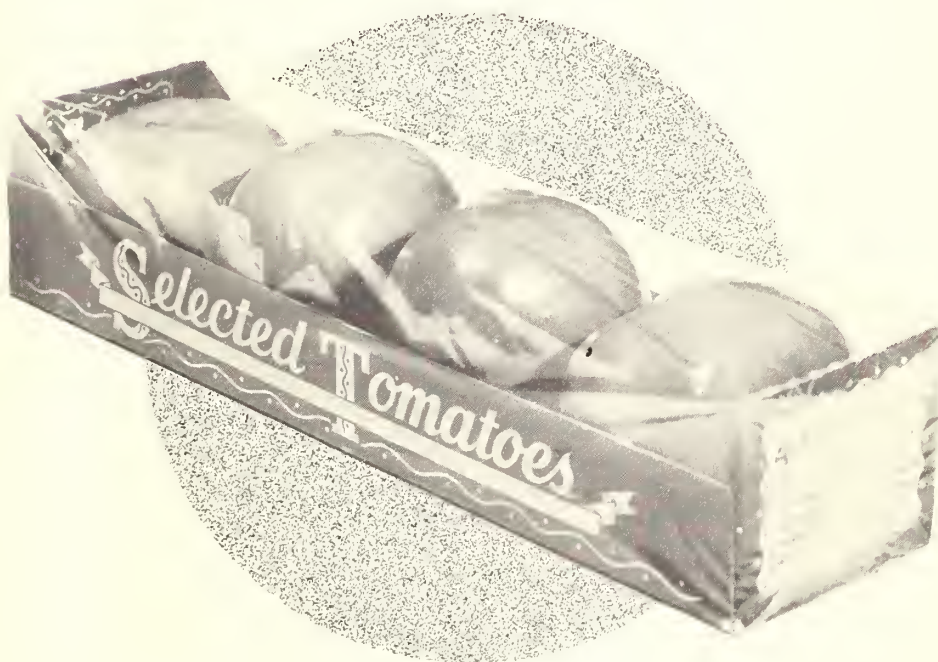
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Prepackaging **TOMATOES**



**UNITED STATES DEPARTMENT OF AGRICULTURE
PRODUCTION AND MARKETING ADMINISTRATION
FRUIT and VEGETABLE BRANCH
Washington, D. C.
OCTOBER 1952**

PREFACE

This report is one of a series issued or sponsored by the Production and Marketing Administration, U. S. Department of Agriculture, on the subject of prepackaging fresh fruits and vegetables. Reports that have already been issued are:

Marketing Florida Prepackaged Sweet Corn, April 1949
(in cooperation with the Florida Agricultural Experiment Station)

Prepackaging Apples at Point of Production, December 1950

Prepackaging Spinach and Kale, August 1951 (in cooperation
with the Maryland Agricultural Experiment Station)

Additional studies, under way, are designed to aid in the development and adoption of more efficient methods and practices of prepackaging other fresh fruits and vegetables.

* * * * *

The study on which this report is based was conducted under the Agricultural Marketing Act of 1946 (RMA, Title II).

ACKNOWLEDGMENTS

Credit is given the following firms for their assistance and cooperation in conducting this survey:

Albee Tomato Co., New York, N. Y.
Baer Bros. Co., Hagerstown, Md.
Chicago Tomato Co., Chicago, Ill.
Thomas Colace Co., Philadelphia, Pa.
Crosset Co., Cincinnati, Ohio
Detroit Tomato & Produce Co., Detroit, Mich.
Fort Pitt Tomato Co., Pittsburgh, Pa.
King Bros., Brooklyn, N. Y.
Leef-Schniebolk Co., New York, N. Y.
William E. Nathan & Son, Chicago, Ill.
Pete Pappas & Son, Washington, D. C.
Spinale Bros., New York, N. Y.
Strazzula Bros. Co., Boston, Mass.
James C. Thomas, Inc., Plymouth, Pa.
Twin Packing Co., Inc., Philadelphia, Pa.
Buck Weiss, Rothman & Solomon, Newark, N. J.
Yeckes-Eichenbaum of Newark, Inc., Newark, N. J.

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SUMMARY

In a study of 14 tomato prepackaging plants, it was found that these plants could, on the average, increase their labor efficiency by 36 percent if they all used the most efficient methods and practices found among them. If the plants are typical of the entire tomato prepackaging industry, it is estimated that general adoption of the most efficient methods and practices should result in an annual saving of more than $2\frac{1}{4}$ million dollars in direct labor cost. However, some plants, particularly those using extensive manual operations, would probably find it necessary to invest in more mechanized equipment than they now have.

Most of these savings would arise from performing the sorting and packaging operations more efficiently than at present.

Setting up and filling consumer packages with tomatoes accounted for 34.1 percent of the total direct labor used in the 14 plants. The most efficient method of filling trays was partial tray filling at a conveyor belt, whereby each operator placed 1 or 2 tomatoes into a mechanically set-up tray moving down a conveyor belt. This method required 2 to 5 operators to completely fill a tray, in contrast to having each operator fill a complete tray. By using this method, a crew of 10 tray-fillers could set up and fill 3,970 consumer packages of tomatoes an hour, as compared with 2,880 consumer packages an hour, the average production rate found in the 14 plants surveyed.

Sorting the tomatoes accounted for 25.6 percent of the total direct labor used. Of the 4 methods of sorting that were observed, sorting from 1 conveyor belt onto other conveyor belts was found the most efficient. This method involved sorting the tomatoes, according to their stage of ripeness, from a main conveyor belt onto other conveyor belts. On the assumption that the average weight of a carload of tomatoes is 24,000 pounds, sorting 1 carload by this most efficient method would require only 20 man-hours, compared with an average of 34 man-hours found in the 14 plants surveyed.

It was also found to be considerably more efficient to dump unwrapped tomatoes that were purchased in large, jumble-packed containers than to dump and remove the wrappers from wrapped tomatoes received place-packed in the standard lug box. This difference in man-hour requirements was 0.07 man-hour for a 100 pounds, which would amount to approximately 17 man-hours for a carload of tomatoes.

Setting up, filling, and closing master shipping containers for prepackaged tomatoes was the third most important operation, and accounted for 9.9 percent of the total direct labor used. Two types of single-layer fiberboard boxes--the one-piece self-locking box and the two-piece telescope box--constituted about 60 percent of all the master containers used for the shipment of prepackaged tomatoes by the 14 plants studied.

The amounts of direct labor used to perform other specified operations, expressed as percentages of the total direct labor used, were: Removing containers of unripe tomatoes to the ripening rooms, 4.8; dumping tomatoes onto the sorting conveyor belt, 4.5; supplying ripe tomatoes to the packaging line, 3.2; supplying containers of tomatoes to the sorting line, 3.0; removing full master shipping containers of prepackaged tomatoes from the packaging line to holding, selling, or shipping areas, 2.9; handling empty shipping containers, 2.5; loosening paper wrappers from tomatoes, 2.1; operating overwrapping machines, 2.1; and other operations, 5.3.

Suggested layouts were developed for small- and large-size tomato prepackaging plants, each based on a combination of methods that were evaluated as the most efficient in use of labor. Sorting from a conveyor belt into bins is recommended for

small plants. Sorting from a conveyor belt onto other conveyor belts is recommended for large plants, as is the use of two separate sorting lines--one for initial sortings of fresh receipts and one for re-sortings of ripened tomatoes. Partial tray filling at a conveyor belt is recommended for both sizes of plants. Other most efficient methods and equipment for performing various, less important operations were also incorporated into these layouts.

Waste and spoilage losses were also an important cost factor and approximated in importance the total cost of direct labor. A total of 11.7 percent of the tomatoes handled through the prepackaging plants surveyed was unmarketable in consumer packages. During the course of this study, 5 of the surveyed plants purchased and received tomatoes exclusively in place-packed lug boxes and 6 plants received their tomatoes exclusively in the larger, jumble-packed containers. In the 5 plants that purchased tomatoes exclusively in lug boxes, waste and spoilage losses averaged 7.0 percent of the quantity of tomatoes handled, as compared with 15.8 percent in the 6 plants that purchased tomatoes in the larger, jumble-packed containers. However, it is possible that comparable grade tomatoes were not packed in these two types of containers. Some of the tomatoes that were unfit for prepackaging in consumer units or for repacking into other types of containers were sold at greatly reduced prices to soup processors or pastry makers.

The cost of waste and spoilage losses, if valued on the basis of the price paid for the tomatoes by the prepackager, averaged 9.5 percent of the value of tomatoes handled in the 14 plants. Comparable losses were 6.1 percent in the 5 plants that handled tomatoes exclusively in lug boxes, and 14.2 percent in the 6 plants that handled tomatoes exclusively in the larger, jumble-packed containers.

In order to provide a means of ascertaining the average quality and condition of prepackaged tomatoes available to consumers in retail stores, 423 packages containing 1,673 tomatoes were purchased in 141 retail stores in 10 eastern and midwestern cities. Purchases were made so that 60 percent of the tomatoes purchased were packaged by the plants surveyed and 40 percent by plants not included in the survey.

A total of 87 percent of the 1,673 tomatoes purchased was found in a salable condition, and 22 percent were judged "perfect," that is, without defects of any kind. Although 78 percent of all the tomatoes purchased were found to be imperfect in one way or another, only 13 percent were considered to be in unsalable condition. These were moldy, rotten, or immature.

The average net weight of the 423 packages of tomatoes purchased was 14.1 ounces. Packages of 5 tomatoes each averaged 13.3 ounces; packages containing either 3 or 4 tomatoes each averaged 14.3 and 14.2 ounces, respectively. Packages containing 5 tomatoes, however, provided more value in terms of price per pound than packages containing 3 or 4 tomatoes.

Seventy-eight percent of the prepackaged tomatoes purchased in retail stores were firm-ripe or hard-ripe, which are generally considered the most desirable stages of ripeness by store patrons. Seventeen percent were soft-ripe, and 5 percent were pinks or turns. There was no significant relationship between the quantities of tomatoes found defective in retail stores and the types of shipping containers in which mature green tomatoes were received at the plants that prepackaged them, despite the greater amount of waste in plants receiving tomatoes in large, jumble-packed containers.

To summarize, it was found that: (1) An average 24 percent reduction in labor costs could be achieved in terminal market tomato-prepackaging plants by adoption of more efficient operating methods; (2) additional labor savings could be obtained by receiving tomatoes in large, jumble-packed containers instead of in lug boxes,

although waste and spoilage losses were found to be greater in plants that purchased their tomatoes in the larger containers; and (3) a total of 78 percent of prepackaged tomatoes purchased in retail stores were imperfect, 37 percent were pressure bruised, and 13 percent were in an unsalable condition. It is evident, therefore, that further increases in the efficiency of prepackaging tomatoes should not be achieved at the expense of rougher handling of the tomatoes, which might cause greater deterioration in their average quality.

PREPACKAGING TOMATOES¹

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and

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INTRODUCTION

Need for This Study

Shipping containers used for mature green tomatoes--their limitations.--The rapid growth of tomato prepackaging at terminal points has influenced a shift in the use of various types of containers in which mature green tomatoes are shipped to terminal markets. It is estimated that about 75 percent of the fall, winter, and spring tomatoes shipped from southern producing areas to northern terminal markets are sorted, ripened, and prepackaged in these terminal markets. This sorting, ripening, and packaging at terminal market would appear to eliminate some of the need for the usual careful hand wrapping and hand packing of individual tomatoes into lug boxes at shipping point, because they have to be unwrapped and again sorted on arrival at the terminal-point prepackaging plant. Because of the need for eliminating this double work, larger, jumble-packed shipping containers have come into more use than the lug box, for shipping unwrapped mature green tomatoes to terminal markets. Some of the newer containers are the 60-pound field crate, which is shipped without a lid, the lidded 50- or 60-pound wirebound crate, and the lidded 60-pound nailed crate. There has arisen a need for some quantitative estimate of the advantages and disadvantages, particularly to terminal market prepackagers, of the various shipping containers for mature green tomatoes. However, the shipping container problem is only one factor affecting over-all efficiency in prepackaging tomatoes.

Need for appraisal of comparative efficiency of various methods and practices used in prepackaging tomatoes.--The terminal market prepackaging of tomatoes is a new industry, and has not had ample opportunity for a shake down of its practices to the most efficient levels. Prepackaging operations range from the small hand operations of intermittent prepackagers to those of large concerns operating a number of plants with a large investment and employing the services of 50 or more workers in each plant. A great variety of practices and equipment, most of them "home-made," have resulted.

The various operations performed in a prepackaging plant, such as sorting the tomatoes, handling empty shipping containers, moving tomatoes to and from the ripening rooms, setting up the cardboard trays and filling these trays with tomatoes, overwrapping the trays with transparent film, setting up master shipping containers, and filling these containers with the overwrapped trays of tomatoes, are performed with varying amounts of hand labor and mechanized equipment. Development and adoption of more efficient prepackaging practices should result in lowered costs of distribution and may possibly increase consumption of fresh tomatoes.

¹ The study on which this report is based was planned and directed by Donald R. Stokes, in charge of research on prepackaging fresh fruits and vegetables, Fruit and Vegetable Branch. R. K. Showalter and A. H. Spurlock, of the Florida Agricultural Experiment Station, assisted in the initial phases of the study.

Difficulty of marketing prepackaged tomatoes of uniform quality and condition. Marketing prepackaged tomatoes of a uniform quality and condition acceptable to consumers is difficult because (1) the quality of mature green tomatoes available to prepackers varies a great deal; (2) tomatoes must be prepackaged at a less advanced stage of ripeness than when they are sold to the consumer; and (3) defects serious enough to make tomatoes inedible at the time they are sold in retail stores may not be apparent when they are prepackaged. These factors, combined with the fact that prepackers have little or no control over the conditions under which the tomatoes are sold in retail stores, have contributed to variations in the quality and condition of prepackaged tomatoes available to consumers.

Despite the rapid increase in sales of prepackaged tomatoes, consumers have frequently been dissatisfied with their quality. One object of this study was to measure and give an impartial estimate of the quality and condition of prepackaged tomatoes available to consumers.

Method and Objectives of Study

Scope and method of this study.--This project was undertaken to help solve three problems outlined in the foregoing section. Its objectives were:

1. To determine the comparative amount of waste and spoilage losses and the efficiency of labor in handling tomatoes received in different types of shipping containers in terminal market prepackaging plants.
2. To determine the comparative efficiency of labor in using various methods and practices of prepackaging tomatoes.
3. To determine the general quality and condition of prepackaged tomatoes on sale in retail food stores.

Early attempts to find answers to some of the three problems by making controlled test shipments of mature green tomatoes in various types of containers were abandoned because it was found impractical to follow the identity of the test tomatoes through the terminal market prepackaging plant.

In order to gain information about the tomato prepackaging operations then in existence, during the month of December 1949, a questionnaire survey was made of 124 prepackers in eastern and midwestern terminal markets. States included in the survey were Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, Ohio, Michigan, Indiana, and Illinois. Of the 67 prepackagers who replied to the preliminary survey, 14 were chosen for a more intensive survey. The choice of these prepackers was based upon their reported volumes of operation, the types of containers in which they reported receiving their mature green tomatoes, and their location.

Four schedules were developed for gathering data from each of the 14 tomato prepackaging plants. One schedule was used to record information obtained from interviewing company officers about business policies; a second to record information on volume of production and on the methods, equipment, and organizations used in the performance of the various operations in the prepackaging plant; and a third schedule was used to sample systematically the distribution of worker effort among these operations.

A fourth schedule was used to record detailed information on each of 1,673 tomatoes purchased in 423 consumer packages in 141 retail stores, in order to evaluate the quality and condition of the tomatoes in terms of types and frequencies of specified defects, size, stage of ripeness, and according to package characteristics and prepackaging practices. For each of the 14 prepackaging plants studied, 10 retail stores were visited and 3 packages of tomatoes were purchased in each store. In each of six of these stores, three packages of tomatoes were purchased that had been prepackaged in the plant studied. In each of the remaining four stores visited, three packages of tomatoes were purchased that had been prepackaged in

other plants. Three additional packages were purchased in another store, making the total number of packages purchased 423 and the total number of retail stores visited 141.

The 14 prepackaging operations fell almost equally into the three prepackaged volume-of-production groups listed below:

<u>Prepackaged volume during week of observation</u>	<u>Number of selected prepackers</u>
More than 75,000 lbs.	4
30,000 lbs. to 74,999 lbs.	5
Less than 29,999 lbs.	5
Total.....	<u>14</u>

During the period that this study was conducted, the 14 prepackaging plants received mature green tomatoes in the following types of shipping containers:

<u>Type of container</u>	<u>Number of selected prepackers</u>
Lug boxes only.....	5
Field crates only.....	2
Wire-bound crates only.....	1
Nailed crates only.....	0
Lug boxes and wire-bound crates.....	2
Field crates and wire-bound crates...	3
Lug boxes and nailed crates.....	1
Total	<u>14</u>

The 14 prepackaging plants were studied in 10 eastern and midwestern cities during 1950 according to the following schedule:

<u>Terminal market</u>	<u>Number of prepackaging operations studied</u>	<u>Time during which studied</u>
Philadelphia, Pa.	1	Jan. 30 - Feb. 10
Newark, N. J.	1	Feb. 12 - 19
New York, N. Y.	4	Feb. 29 - March 29
Cincinnati, Ohio.....	1	March 14 - 20
Plymouth, Pa.	1	March 20 - 27
Hagerstown, Md.....	1	March 27 - April 4
Chicago, Ill.....	2	Apr. 25 - May 10
Detroit, Mich.	1	May 14 - 20
Pittsburgh, Pa.....	1	May 28 - June 3
Boston, Mass.	1	June 20 - 26
Total	<u>14</u>	<u>Jan. 30 - June 26</u>

Limitations of method used.--Although the prepackaging plants chosen for study were selected in a manner to assure their adequate representation according to (1) sales volumes, (2) the types of shipping containers in which mature green tomatoes were received, and (3) location in the eastern and midwestern United States, it was impossible to estimate these three characteristics as they applied to all prepackagers in this part of the country. The prepackaging plants studied are therefore not necessarily a representative sample of all the tomato prepackaging plants in the eastern and midwestern parts of the country.

Another limitation of the method of study used was the relatively short time spent by U. S. Department of Agriculture observers at each of the prepackaging plants surveyed. Each complete workweek observed for each plant may not have been typical of its long-term operation. Because a survey rather than an experimental approach was used to estimate the comparative efficiencies of the various methods and practices used in the prepackaging plants surveyed, the results presented can be no more than examples of the more efficient methods and practices observed. Evaluation of existing techniques is no substitute for the development of new techniques, and it is hoped that the latter concept will take over where the former leaves off.

Another limitation applies to that part of the survey in which an attempt was made to learn of the quality of prepackaged tomatoes in retail stores. The purchase of the prepackaged tomatoes through the 5 months from February through June 1950, would cause these data to reflect differences in tomato quality associated with the different producing areas in which the tomatoes were grown. Another limitation of the tomato quality study was that no evaluations were made of the comparative severity of the various tomato defects observed--records were made only of their occurrence.

ADVANTAGES AND DISADVANTAGES OF DIFFERENT SHIPPING CONTAINERS FOR MATURE GREEN TOMATOES

Extent to Which Different Shipping Containers Were Used by Prepackagers Surveyed

Preliminary 36-plant survey, December 1949.--During December 1949 a questionnaire survey was made of 124 prepackagers of tomatoes at terminal markets in the eastern and midwestern States. A total of 36 prepackagers responded with the required information which revealed that their comparative receipts of tomatoes that month in the following 4 types of shipping containers were as follows:

<u>Type of shipping container in which tomatoes were re- ported received</u>	<u>Percentage of all tomatoes reported received by 36 tomato prepackers</u> <u>Percent</u>
Lug box.....	52
Field crate	32
Wire-bound crate.....	11
Nailed crate.....	5
Total	100

A lug box (fig. 1) is a wooden box holding approximately 32 pounds, net weight, of tomatoes.² The inside dimensions of the most common type of lug box are approximately 6-7/16 by 13-1/2 by 16-1/8 inches. Tomatoes shipped in lug boxes are first graded to standard size and then individually hand-wrapped and place-packed in the lug boxes. The lug box used in Florida and in other southeastern areas differs slightly in its inside dimensions from that in the western tomato-producing areas, but otherwise it is substantially the same.

Field crates, nailed crates, and wire-bound crates are usually jumble-packed with 60 pounds of nonwrapped tomatoes for shipment to terminal markets, although some smaller wire-bound crates holding 50 pounds of tomatoes were observed arriving at terminal market prepackaging plants. Nailed crates and wire-bound crates are lidded for shipment to terminal markets. Field crates usually are shipped without lids. Field crates and nailed crates appear more rigidly constructed than wire-bound crates (fig. 1).

Case studies of 14 plants, January-June 1950.--The percentage of tomatoes received in the four types of containers at the 14 plants surveyed between January and June 1950 were: Lug boxes, 43 percent; field crates, 35 percent; wire-bound crates, 18 percent; and nailed crates, 4 percent. (See table 1.)

Operators of tomato prepackaging plants that received most of their tomatoes in lug boxes reported that they usually procured tomatoes through brokers and from independent shippers, terminal market auctions, growers, and their own packing sheds. Operators of those plants receiving their tomatoes mostly in field crates, wire-bound crates, and nailed crates reported procuring most of their mature green tomatoes through brokers and from growers.

When asked "In what type of shipping container do you prefer to buy your tomatoes?", 8 of the operators of the 14 surveyed tomato prepackaging plants named field crates, 4 said lug boxes, 1 said nailed crates, and 1 gave a qualified answer, replying that he preferred field crates for tomatoes shipped from Florida and lug boxes for tomatoes shipped from other producing areas.

² Although lug boxes frequently are considered as holding 30 pounds of tomatoes each, they often are packed with as much as 34 pounds. An average of 32 pounds of tomatoes per lug box was therefore used as a conversion factor in this study.



Figure 1.—Shipping containers for mature green tomatoes. Left to right: Wire-bound crate, nailed crate, and field crate—each jumble-packed with approximately 60 pounds of tomatoes--and a lug box place-packed with approximately 32 pounds of tomatoes.

TABLE 1.—Percentages of tomatoes received in specified types of shipping containers, based on 1 week of observation in each of 13 tomato prepackaging plants in 10 eastern and midwestern cities, February-June 1950

Type of container	Plants surveyed	Weight of tomatoes received during week surveyed	Percentage of tomatoes received in specified types of shipping containers during week surveyed				
			Lug boxes	Field crates	Wire-bound crates	Nailed crates	Total
	<i>Number</i>	<i>Pounds</i>	<i>Per-cent</i>	<i>Per-cent</i>	<i>Per-cent</i>	<i>Per-cent</i>	<i>Per-cent</i>
Lug boxes.....	5	243,200	100				100
Large, jumble-packed containers.....	6	375,480		68	26	6	100
Lug boxes and large, jumble-packed containers.	2	103,094	64		29	7	100
Total or average.....	¹ 13	721,744	43	35	18	4	100

¹ Although one plant received no tomatoes during the time it was surveyed, it did dump from both lug boxes and large jumble-packed containers the tomatoes it had purchased previously.

One of the reasons given for their preference by 5 of the 8 prepackaging plant operators who preferred field crates was their belief that this type of container was more efficient to handle in the prepackaging plant. Two said that field crates are easier to handle, two said that wrappers do not have to be removed from tomatoes purchased in field crates, one said that tomatoes keep better when shipped in field crates, and one said that he prefers field crates because they can be re-used in shipping tomatoes from the producing area to his tomato prepackaging plant.

Each of the four plant operators who preferred lug boxes gave as one of the reasons for his preference his belief that tomatoes keep better when shipped in this type of container. In addition, two considered lug boxes "more dependable," two claimed that lug boxes were more efficient or easier to handle in the prepackaging plant, and one preferred lug boxes because he thought that they usually contain a "more uniform pack" of tomatoes.

The tomato prepackaging plant operator who preferred nailed crates, claimed that they were more efficient and easier to handle in the plant.

Comparative Costs and Re-Use Values of Shipping Containers

During the time this study was conducted, lug boxes cost about 33.5 cents each. Empty lug boxes had a re-sale value of 5 to 10 cents in most terminal markets, and many were retained in the prepackaging plants for use in storing and ripening tomatoes or as master containers for prepackaged or repacked tomatoes. Field crates cost from \$1.00 to \$1.25 each. Tomato prepackers usually owned their field crates outright and, by returning the empty field crates to shipping point for additional shipments of tomatoes, were able to amortize the cost of these crates over about 10 shipments, or at a rate of about 10 to 12 cents a trip. The operator of one unusually large prepackaging plant not included in this survey reported in 1951 that this plant's container expense for field crates averaged about 17 cents a crate for a round trip. This expense consisted of 12 cents for returning the empty crate to shipping point and 5 cents for amortizing the \$1.05 initial cost of the container.

During the time this study was conducted, wire-bound crates cost about 33.5 cents each, and nailed crates about 34.5 cents. The tomato prepackers surveyed reported that nailed crates and wire-bound crates had no resale value in their terminal markets and no re-use value in their plants. However, there are reports of the use of smaller wire-bound crates by tomato prepackers as master containers for pre-packaged tomatoes.

Comparative Efficiencies of Dumping, Stripping,
and Sorting Tomatoes Received in Different-
Type Shipping Containers

Dumping and stripping.--It was found that dumping nonwrapped tomatoes from large, jumble-packed containers onto a sorting conveyor belt was one-fourth as costly as dumping and loosening the paper wrappers from tomatoes that had been hand-wrapped and individually packed in lug boxes. The average direct labor cost in eight plants for dumping and loosening wrappers from 100 pounds of tomatoes received in lug boxes was 9.4 cents (table 2). Comparable labor costs in five plants that received

TABLE 2.—Comparative efficiency and cost of direct labor required to dump and loosen wrappers¹ from tomatoes and redump them, according to types of tomato containers based on 1 week of observation in each of 14 prepackaging plants in 10 eastern and midwestern cities, February-June 1950

Type of container from which tomatoes were dumped	Plants surveyed	Quantity of tomatoes dumped	Man-hours of labor per 100 pounds dumped	Labor cost	
				Average hourly wage rate	Per 100 pounds dumped
	<i>Number</i>	<i>100 pounds</i>	<i>Man-hours</i>	<i>Dollars</i>	<i>Cents</i>
Original receipts only:					
Lug boxes.....	8	2,387.6	0.089	1.06	9.4
Field crates.....	5	2,422.3	.017	1.19	2.0
Wire-bound crates.....	7	880.3	.020	.96	1.9
Nailed crates.....	1	487.7	.027	1.34	3.6
Total or average.....	² 14	6,177.9	.046	1.08	5.0
Redumping of previously sorted tomatoes:					
Lug boxes.....	13	³ 6,461.4	0.027	1.10	3.3
35-pound containers ⁴	1	24.1	.046	1.10	5.1
Wire-bound crates.....	2	676.0	.040	1.07	4.3
Total or average.....	² 14	7,161.5	.031	1.09	3.4
Total or average.....	² 14	13,339.4	.038	1.09	4.1

¹ "To dump and loosen wrappers," as used in this table means (1) to remove container of tomatoes from pile or from materials-handling equipment at dumping station; (2) to place it on dumping table at end of sorting conveyor belt; (3) to remove its lid, if lidded; (4) to tilt container, slowly emptying contents onto sorting conveyor; (5) to dispose of empty container to nearby pile or materials-handling equipment; (6) to stack lids and tie them into bundles for removal from plant; and (7) to loosen the paper wrappers from tomatoes that were individually wrapped at shipping point, prior to the removal of the wrappers by a suction tube, or blower.

² The number of plants totals more than 14 because in some plants tomatoes were dumped from more than one type of container.

³ An additional 58,890 pounds of tomatoes re-sorted in these plants were re-sorted manually, from one container into other containers, and therefore no labor was used to dump these tomatoes onto the sorting conveyor belt.

⁴ These containers were specially constructed for use in one plant.

tomatoes in field crates and in seven plants that received tomatoes in wire-bound crates were 2.0 and 1.9 cents per 100 pounds, respectively. The average direct labor cost for dumping tomatoes from nailed crates in one plant was 3.7 cents per 100 pounds.

The greater cost involved in dumping and loosening wrappers from lug boxes of tomatoes was due chiefly to (1) the necessity of removing the lids; (2) the smaller quantity of tomatoes handled at each dumping, thus requiring more handling per quantity dumped; and (3) the necessity of loosening the paper wrappers from the tomatoes prior to the removal of the wrappers by a suction tube, or blower.

At the first sorting, unripe tomatoes were usually placed into lug boxes, 20 pounds to the box, and removed to the ripening rooms for further ripening. These lug boxes of tomatoes were later brought from the ripening rooms to be redumped and re-sorted. At 13 plants where redumpings were from lug boxes, the average cost of redumping was found to be 3.3 cents per 100 pounds redumped. (See table 2.) This cost for redumping tomatoes from lug boxes was about one-third that for initial dumpings and strippings of tomatoes from original lug boxes, because lids did not have to be removed from the containers and the paper wrappers did not have to be loosened from the tomatoes. On the other hand, the average cost of redumping previously sorted tomatoes from lug boxes holding 20 pounds each was about one-and-one-half times as great as the average cost of initial dumpings of tomatoes from original large jumble-packed containers because it was comparatively less efficient to dump smaller quantities of tomatoes from these smaller boxes.

Sorting.--The amount of direct labor required to sort tomatoes dumped from their original shipping containers varied considerably between plants and ranged from 0.049 man-hour to 0.192 man-hour per 100 pounds of tomatoes sorted. An average of 0.116 man-hour of direct labor was required to sort 100 pounds of tomatoes in 8 plants that received tomatoes in lug boxes, as compared with an average of 0.109 man-hour in 5 plants that received tomatoes in field crates and 0.099 man-hour in 7 plants that received tomatoes in wire-bound crates (table 3). Three of the 14 plants received shipments of mature green tomatoes in lug boxes and also in wire-bound crates. In one of these plants the initial sorting operation was performed more efficiently on those tomatoes received in lug boxes than on those received in the larger containers, and in the other two plants the sorting operation was performed more efficiently on those tomatoes received in wire-bound crates. Therefore, there is little, if any, conclusive evidence that the type of shipping container affects the efficiency of the sorting operation.

It was also found that slightly more labor was required to re-sort tomatoes than to sort initially. This is probably due to the fact that there is likely to be a greater range of ripeness among the tomatoes after they have been stored for some time in the ripening rooms than when they were originally received at the plant.

Comparative Waste and Spoilage Losses
of Tomatoes in Plants Receiving Tomatoes in
Different Types of Shipping Containers

Tomato prepackaging plants receiving lug boxes of individually wrapped place-packed tomatoes had less than half as much waste and spoilage for an equivalent weight of tomatoes handled as did plants receiving tomatoes jumble-packed in larger containers. At 5 plants that received mature green tomatoes exclusively in lug boxes, waste and spoilage (including those tomatoes sold to soup and pastry processors, etc.) averaged 7.0 percent of the quantity of tomatoes handled, as compared to 15.8 percent at 6 plants receiving tomatoes exclusively in larger, jumble-packed containers (table 4). Waste and spoilage averaged 10.4 percent of the quantity of tomatoes handled at 3 plants that received tomatoes in both lug boxes and the larger, jumble-packed containers, and the average loss in all 14 plants amounted to 11.7 percent.

TABLE 3.--Comparative efficiency and cost of direct labor for sorting tomatoes,¹ according to types of containers from which tomatoes were dumped, based on 1 week of observation in each of 14 prepackaging plants in 10 eastern and midwestern cities, February-June 1950

Type of container	Plants surveyed	Quantity of tomatoes sorted	Man-hours of labor per 100 pounds sorted	Labor cost	
				Average hourly wage rate	Per 100 pounds sorted
	<i>Number</i>	<i>100 pounds</i>	<i>Man-hours</i>	<i>Dollars</i>	<i>Cents</i>
Original receipts only:					
Lug boxes.....	8	2,387.6	0.116	1.08	12.5
Field crates.....	5	2,422.3	.109	.96	10.5
Wirebound crates.....	7	880.3	.099	.96	9.5
Nailed crates.....	1	487.7	.101	1.12	11.3
Total or average.....	² 14	6,177.9	.110	1.02	11.2
Re-sorting of previously sorted tomatoes:					
Lug boxes.....	14	7,050.3	0.184	1.00	18.4
35-pound containers ³	1	24.1	.144	1.10	15.8
Wirebound crates.....	2	676.0	.134	1.07	14.3
Total or average.....	² 14	7,750.4	.167	1.01	16.9
Total or average.....	² 14	13,928.3	.141	1.01	14.2

¹ To "Sorting," as used in this table, includes selecting tomatoes and placing them into appropriate container or bin, or onto appropriate conveyor, according to their quality, condition, size, and stage of ripeness.

² Number of plants totals more than 14 because in some plants tomatoes were dumped from more than one type of container.

³ These containers were specially constructed for use in one plant.

Most prepackagers sold some tomatoes, such as soft ripe tomatoes, to soup and pastry processors; consequently, the value of waste and spoilage losses, as a percentage of the cost of the tomatoes to the prepackagers, averaged less than the percentage of tomatoes which were unmarketable in consumer packages. The value of waste and spoilage losses averaged 9.5 percent for all 14 plants, 6.1 percent in the 5 plants that received their tomatoes in lug boxes, and 14.2 percent in the 6 plants that received their tomatoes in larger, jumble-packed containers.

U. S. Department of Agriculture inspection certificates indicate that a greater proportion of U. S. No. 1 grade mature green tomatoes are shipped in lug boxes than in larger, jumble-packed containers. This points toward the probability that the greater waste and spoilage losses observed in plants receiving their tomatoes in the larger containers may have been due primarily to the lower quality of the tomatoes originally packed in them rather than to the effect of the container on the tomatoes. This probable difference in quality is further substantiated by the difference in the prices paid for tomatoes by the plants surveyed, which averaged 8.8 and 12.4 cents a pound in lug boxes and larger jumble-packed containers, respectively.

TABLE 4.--Comparative waste and spoilage losses in 14 tomato prepackaging plants in 10 selected eastern and midwestern cities, by types of containers in which tomatoes were received, based on 1 week of observation in each plant, February-June 1950

Type of container	Plants surveyed	Tomatoes handled ¹	Waste and spoilage loss ²		
			Quantity	Percentage of quantity of tomatoes handled	Percentage of cost of tomatoes handled
	<i>Number</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Percent</i>	<i>Percent</i>
Lug boxes.....		20,987	482	2.3	2.1
		22,916	624	2.7	2.5
		89,069	3,728	4.2	4.1
		46,745	3,296	7.1	7.1
		137,372	14,121	10.3	9.7
Total or average.....	5	317,089	22,251	7.0	6.1
Larger, jumble-packed containers.....		49,131	2,147	4.4	4.2
		85,982	5,900	6.9	6.0
		28,574	3,503	12.3	11.8
		101,418	13,056	12.9	10.6
		12,074	2,256	18.7	18.7
		116,291	35,135	30.2	30.2
Total or average.....	6	393,470	61,997	15.8	14.2
Both lug boxes and larger, jumble-packed containers.		35,352	2,407	6.8	6.8
		29,979	3,169	10.6	9.6
		48,940	6,312	12.9	7.5
Total or average.....	³ 3	114,271	11,888	10.4	8.1
Total or average.....	14	824,830	96,136	11.7	9.5

¹ Initial inventory, plus purchases, less final inventory.

² "Waste and spoilage," as here used, includes rejected tomatoes that were discarded, and rejected tomatoes sold in bulk, at a fraction of their original cost, to retailers, soup processors, pastry-makers, etc.

³ Although no tomatoes were received at one plant during the week it was surveyed, during that time tomatoes were dumped from both lug boxes and larger, jumble-packed containers purchased previously.

Relationship Between Direct Costs of
Prepackaging Tomatoes and Type of Shipping Container
in Which Tomatoes were Received

Direct costs in five plants receiving tomatoes exclusively in lug boxes.--The direct costs of prepackaging tomatoes, including the cost of tomatoes, waste and spoilage losses, packaging materials, and labor, were about 22 percent higher in 5 plants that received tomatoes exclusively in lug boxes than in 6 plants that received tomatoes exclusively in larger, jumble-packed containers. Some of the larger containers, however, were field crates, and the cost of using them--original cost amortized over the number of times used and cost of freight in returning them to the shipping point--was not determined. The average imputed cost of 87.5 pounds of packageable tomatoes

TABLE 5.—Comparative average direct costs for prepackaging tomatoes in five prepackaging plants receiving tomatoes exclusively in lug boxes and in six plants receiving tomatoes exclusively in larger, jumble-packed containers, based on 1 week of observation in 11 terminal market plants in 7 eastern and midwestern cities, February-June 1950.

Direct cost	Average costs in 5 plants receiving tomatoes exclusively in lug boxes, per equivalent 100 trays prepackaged ¹	Average costs in 6 plants receiving tomatoes exclusively in larger, jumble-packed containers, per equivalent 100 trays prepackaged ¹
	<i>Dollars</i>	<i>Dollars</i>
Tomatoes, f.o.b. prepackaging plant.....	² 11.00	³ 7.82
Packaging materials ⁴	2.40	2.40
Direct labor.....	⁵ 1 06	⁶ .96
Cost of waste and spoilage losses ⁷	.71	1.29
Total.....	15.17	12.47

¹ Based on trays holding 14 ounces of tomatoes each.

² Based on 94.1 pounds at an average price of \$3.98 per 32-pound lug box f.o.b. prepackaging plant, including cost of container.

³ Based on 103.9 pounds at an average price of \$5.26 for a 60-pound jumble-packed container f.o.b. prepackaging plant, including cost of containers, except for the cost of amortizing and returning field crates, which probably ranges between 30 and 40 cents per 100 trays.

⁴ Based on the following assumed average materials costs:

	<u>Per 100 trays</u>
Film	\$ 0.40
Trays	.30
Master shipping containers.....	1.20
Total.....	<u>\$ 2.40</u>

⁵ Based on observations of 2,877 man-hours used to handle and package 304,820 trays of tomatoes, or an average of 0.944 man-hour for each 100 trays prepackaged, and based on an average hourly wage rate of \$1.127.

⁶ Based on observations of 3,238 man-hours used to handle and package 331,830 trays of tomatoes, or an average of 0.976 man-hour for each 100 trays prepackaged, and based on an average hourly wage rate of \$0.986.

⁷ Valued on the basis of the average weekly purchase price of tomatoes received at each plant during period of observation.

or the equivalent of 100 trays ³ of prepackaged tomatoes was \$11.00 at the 5 plants that received tomatoes in lug boxes (table 5). Assuming packaging materials costs of 40 cents for transparent film, 80 cents for trays, and \$1.20 for master shipping containers, total materials cost per 100 trays averaged \$2.40. Direct labor cost averaged \$1.06 per 100 trays based on an average of 0.944 man-hour for each 100 trays prepackaged and an average hourly wage rate of \$1.127. The cost of waste and spoilage losses, valued on the basis of the average weekly purchase price of tomatoes received at each of the 5 plants during the time it was surveyed, averaged 71 cents per 100 trays prepackaged. These direct costs totaled \$15.17 per 100 trays prepackaged.

³ Based on each tray holding 14 ounces of tomatoes.

Direct costs in six plants receiving tomatoes exclusively in large, jumble-packed containers.--Six plants receiving tomatoes exclusively in large, jumble-packed containers had, on the average, much lower direct costs than the plants receiving tomatoes exclusively in lug boxes. The average imputed cost of the equivalent of 100 trays or 87-1/2 pounds of packageable tomatoes at the 6 plants was only \$7.67 (table 5), or \$3.18 less than the average cost of a comparable amount of tomatoes purchased by plants receiving tomatoes in lug boxes. The average purchase price does not include the cost of using field crates for those surveyed plants that used their own field crates for shipping tomatoes. The cost might range from 30 to 40 cents per 100 trays prepackaged, depending on the amortization cost per trip and the cost of returning the empty field crates to shipping point. Packaging materials costs were estimated at \$2.40 per 100 trays. The cost of direct labor per 100 trays averaged 96 cents, based on an average of 0.976 man-hour for each 100 trays prepackaged and an average hourly wage rate of 98.6 cents. This direct labor cost was 10 cents less than the cost of direct labor per 100 trays at plants receiving tomatoes exclusively in lug boxes due to the difference in hourly wage rates between the 2 groups of plants. The cost of waste and spoilage losses, valued on the basis of the average weekly purchase price of tomatoes received at each of the 6 plants during the time it was surveyed, averaged \$1.29 per 100 consumer packages. Despite the 30 percent lower purchase price of tomatoes at which these losses were valued, waste and spoilage losses at plants receiving tomatoes exclusively in large, jumble-packed containers cost 58 cents more per 100 consumer packages than at plants receiving tomatoes in lug boxes only. As previously stated, however, the total of direct costs at plants receiving tomatoes exclusively in the larger containers was considerably less than at plants receiving tomatoes exclusively in lug boxes, the average being \$12.47 per 100 trays.

Some of the difference in direct costs between the two groups of plants may have been due to differences in management. The effects of these management differences on direct costs were not evaluated in this survey. The effects of price fluctuations on direct costs during the time this survey was conducted were also not evaluated. However, it is estimated that the effect of price fluctuations was at least partially eliminated, since the five plants receiving tomatoes in lug boxes were fairly well interspersed with the six plants receiving tomatoes in the larger containers during the course of the survey.

COMPARATIVE EFFICIENCIES AND COSTS OF VARIOUS METHODS AND PRACTICES OF PREPACKAGING TOMATOES

Operations Performed in a Tomato Prepackaging Plant

In a typical tomato prepackaging plant, receipts of fresh tomatoes usually are first dumped from their original shipping containers onto a long conveyor belt for sorting (fig. 2).

If the tomatoes are individually wrapped at shipping point, the paper wrappers must be removed. This is done by first manually loosening the wrappers and then allowing them to be sucked to another part of the building by a "blower," under which the tomatoes pass while on the sorting conveyor belt (fig. 3).

The tomatoes then pass down the sorting conveyor belt and a crew of operators sorts them according to stage of ripeness (fig. 4). Those tomatoes which are unmarketable in consumer packages are also sorted out during this operation.

Tomatoes that need further ripening are then taken to ripening rooms. Twelve of the 14 surveyed plants were equipped with controlled-conditioned ripening rooms and 2 plants used convenient storage areas near the sorting and packaging lines for ripening tomatoes. Average inventories at the 14 plants were turned over from 0.4 time to 1.1 times a week, and an average of 0.6 time. When the tomatoes in the ripening rooms have reached a more advanced stage of ripeness, they are returned to the sorting conveyor belt for another sorting. The ripe tomatoes are taken off the sorting conveyor belt and removed to the packaging line, where another crew of operators places them into empty consumer packages as these packages pass along a tray-filling conveyor belt (fig. 5).



Figure 2.—A lug box containing approximately 32 pounds of individually wrapped, placed-packed tomatoes is dumped onto the end of the sorting conveyor belt. Note operator loosening paper wrappers before tomatoes pass under blower.

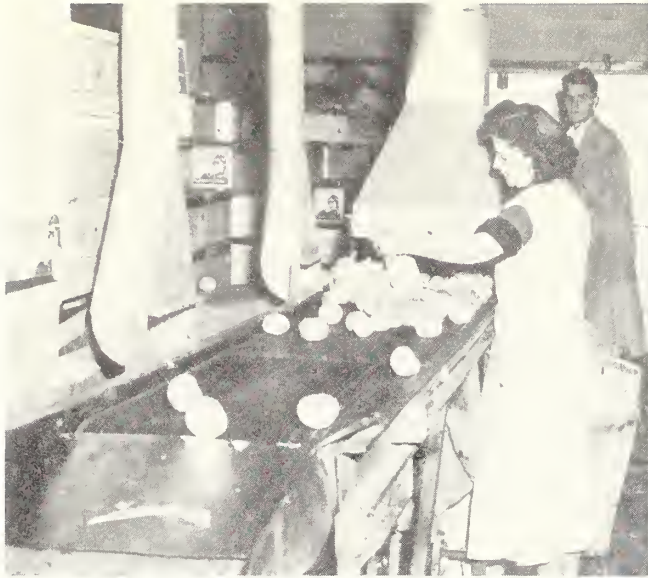


Figure 3.—Tomatoes emerging from under blower. Operator is removing wrappers not removed by blower.

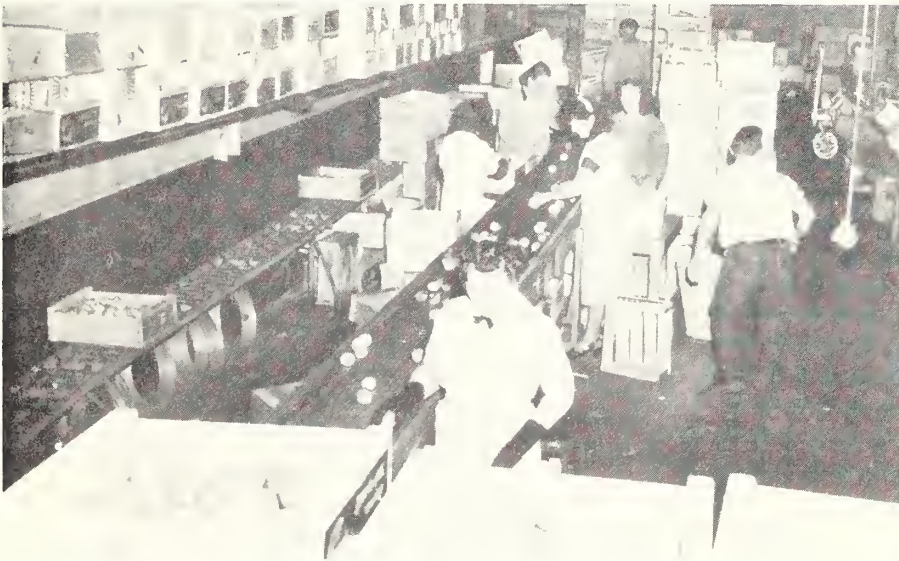


Figure 4.—Crew of operators sorting tomatoes at sorting conveyor belt.

This conveyor feeds the packages into a machine that wraps them in a transparent film. The wrapped packages are then placed into fiberboard master shipping containers (fig. 6), stacked on skids, and taken to a holding, selling, or shipping area (fig. 7).



Figure 5.—Crew of tray-filling operators filling consumer units, or trays, with tomatoes at packaging line. Filled trays then pass along to overwrapping machine, where they are wrapped in transparent film.

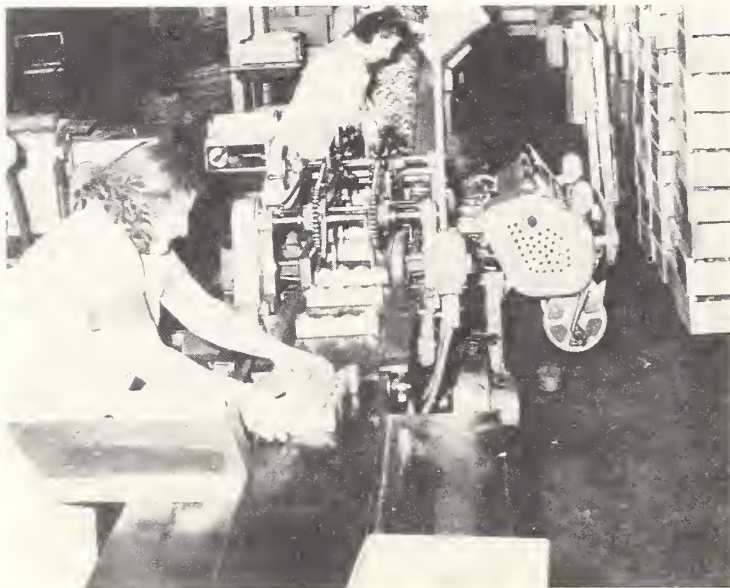


Figure 6.—Wrapped trays of tomatoes emerging from overwrapping machine. Operator places them into a fiberboard master shipping container.

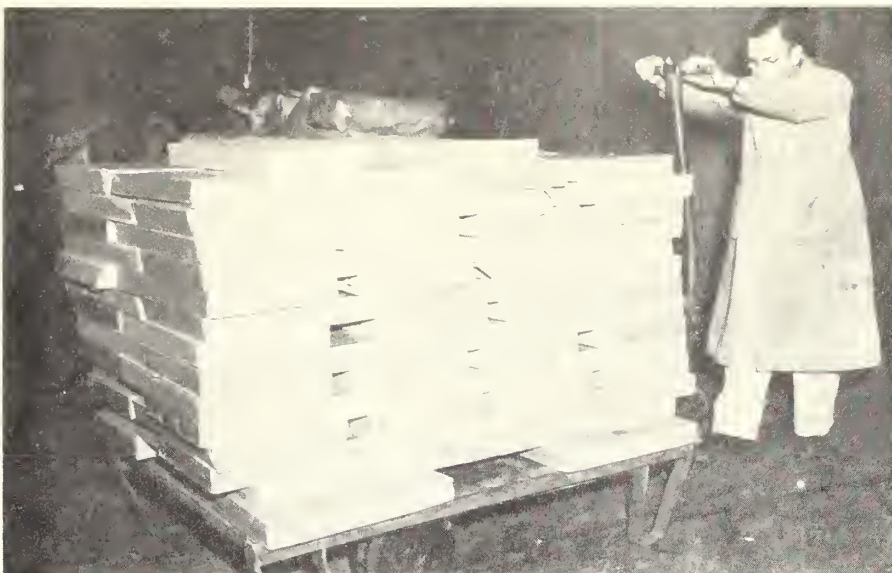


Figure 7.—Operator removes skid of master shipping containers filled with pre-packaged tomatoes.

Not all of the tomatoes handled in tomato prepackaging plants are prepackaged. In the 14 plants surveyed, 69 percent of the total weight of tomatoes handled, excluding tomatoes resold in their original shipping containers, were sold in consumer packages. Nineteen percent were repacked, that is, tomatoes suitable for table use were individually hand-wrapped and repacked into bulk containers, such as lug boxes or 10-pound fiberboard boxes, for resale to retail stores, institutions, etc. Nine percent were rejected as unfit for table use and discarded, and 3 percent, although rejected, were in slightly better condition and were sold in bulk at marked-down prices.

Cost and Average Distribution of Direct Labor by Operations in Prepackaging Tomatoes

Direct labor costs for prepackaging 753,320 trays of tomatoes in the 14 plants surveyed averaged \$1.05 a 100 trays prepackaged (table 6), or 10.5 cents for each master container of 10 trays, or about 1 cent per tray. A considerable variation in the cost of prepackaging tomatoes was found among these plants. Although the average cost of direct labor to prepackage 10 trays of tomatoes was 10.5 cents, the individual plant costs varied from a low of 6.3 cents to a high of 16.5 cents. The two operations that accounted for most of the variation in costs among plants were the sorting and tray-filling operations.

Direct labor costs for the individual plants are not satisfactory measures of the comparative efficiency of labor among plants because of variation among average wage rates. Although the average hourly wage rate among all the surveyed plants was \$1.03, individual labor wage rates in the plants ranged from \$0.75 to \$1.65 an hour.

Sorting of tomatoes and associated operations accounted for an average cost of about 4 cents for each 10 trays of tomatoes, although this cost varied from a low of 2.2 cents to a high of 8.6 cents among the 14 plants surveyed. Filling the trays with tomatoes and associated operations accounted for about 6 cents a container of 10 trays in the 14 surveyed plants, although this cost varied from a low of 3.9 cents to a high of 8.6 cents.

On the average, more direct labor was used in the 14 plants to set up and fill trays than for any other single operation. A total of 34.1 percent of the 7,679 man-hours utilized in the 14 plants during the time they were surveyed was devoted to the tray-filling operation (table 6). Sorting, the next most important operation, accounted for about 25.6 percent of all man-hours of direct labor used. Other operations and the percentages of total direct labor required to perform them were: Setting up, filling, and closing master shipping containers--9.9; removing containers of unripe tomatoes to the ripening rooms--4.8; dumping tomatoes onto the sorting conveyor belt--4.5; supplying tomatoes to the packaging line--3.2; supplying containers of tomatoes to the sorting line--3.0; removing full master shipping containers--2.9; handling empty containers--2.5; loosening wrappers from tomatoes--2.1; operating overwrapping machines--2.1; and other miscellaneous operations--5.3. Operations associated with tray filling, but not including tray filling itself, accounted for about 18 percent of all direct labor; those associated with sorting, but not including sorting itself, accounted for about 17 percent.

The comparative efficiency of different methods of performing each of the above 11 operations as observed in the 14 plants surveyed, is shown in the following part of this report. These various methods are generally discussed and ranked from the least to the most mechanized way of performing each operation.

TABLE 6.—Cost and amount of direct labor used in 14 tomato prepackaging plants in 10 eastern and mid-western cities, by operations, based on 1 week of observation in each plant, February-June, 1950

Operation	Total direct labor used in surveyed plants		Labor cost per 100 trays prepackaged
	<i>Man-hours</i>	<i>Percent</i>	<i>Dollars</i>
Sorting and associated operations:			
1. Supplying tomatoes to sorting line.....	230.9	3.0	0.030
2. Dumping tomatoes onto sorting conveyor belt.	348.1	4.5	.051
3. Handling empty shipping containers.....	194.7	2.5	.026
4. Loosening wrappers.....	157.1	2.1	.020
5. Sorting.....	1,968.1	25.6	.263
6. Removing containers of unripe tomatoes to ripening rooms.....	364.2	4.8	.044
Total, sorting and associated opera- tions.....	3,263.1	42.5	.434
Tray-filling and associated operations:			
7. Supplying tomatoes to packaging line.....	242.8	3.2	.030
8. Setting up and filling trays.....	2,617.5	34.1	.375
9. Operating overwrapping machines.....	164.5	2.1	.024
10. Setting up, filling, and closing master shipping containers.....	764.8	9.9	.105
11. Removing full master shipping containers....	222.2	2.9	.030
Total, tray-filling and associated operations.....	4,011.8	52.2	.564
Other operations.....	404.5	5.3	.053
Total, all operations.....	7,679.4	100.0	1.051

Methods of Supplying Containers of Tomatoes to Sorting Line

Method 1.--Manual transfer.--The first operation performed in the tomato pre-packaging plants surveyed was bringing containers of tomatoes from either the unloading dock or the ripening rooms to the dumping station at the sorting conveyor belt. Of the six methods studied, the least efficient method of performing this operation was the manual transfer of containers of tomatoes one or two at a time, from stocks on the ripening-room floors or nearby ripening areas to the sorting line. In the two plants that used this method, an average of 0.091 man-hour was required to move 100 pounds of tomatoes 100 feet (table 7).

Method 2.--Hauling on handtrucks.--Hauling containers of tomatoes on handtrucks was one of the least efficient methods of supplying tomatoes to the sorting line. In two plants surveyed where this method was used, an average of 0.062 man-hour was required to move 100 pounds of tomatoes 100 feet.

Method 3.--Hauling on skids.--This method was used in five plants and was found more efficient than any other method. It required an average of 0.015 man-hour to move 100 pounds of tomatoes 100 feet. The same skids were used for storing the tomatoes in the ripening rooms as well as for hauling them, and, therefore, it was not necessary to load or unload the tomatoes in the ripening room, as was necessary when hand trucks were used.

Method 4.--Placing on conveyors.--The use of conveyor systems to bring tomatoes to the sorting line required an average of 0.070 man-hour to move 100 pounds of tomatoes 100 feet. This method involved loading conveyors with containers of tomatoes from stacks piled on the ripening room floor and was used in only one plant.

Method 5.--Combined manual transfer and use of skids.--At one plant, containers of tomatoes were hauled part of the way to the sorting line on skids, as described in method 3, and were manually transferred the rest of the distance, as described in method 1. This was done in order to keep open needed aisle space next to the dumping table at the sorting line, and this method was the third most efficient of the six methods studied. In this plant an average of 0.025 man-hour of direct labor was required to move 100 pounds of tomatoes 100 feet.

Method 6.--Combined use of skids and conveyors.--In three plants, both skids and conveyors were used either alternately or in combination in order to overcome the difficulties of multi-story operation. This method was the second most efficient one studied, requiring an average of 0.024 man-hour to move 100 pounds of tomatoes 100 feet.

In general, it was found that the use of skids, either alone or in combination with some other method, provided the most efficient way of supplying containers of tomatoes to the sorting line. The use of skids eliminates the necessity of performing the loading operation when tomatoes are brought out of the ripening rooms to be resorted, because the tomatoes stay on the skids during the ripening process. A substantial proportion of the sorting operation consisted of resorting tomatoes that had been ripened in the ripening rooms.

Methods of Dumping Tomatoes onto Sorting Conveyor Belt

Only one general method of dumping tomatoes onto the sorting conveyor belt is employed. An operator usually manually lifts the container up to the dumping table and slowly tips it over on one side so that the tomatoes roll out upon the conveyor belt. However, because the lids have to be taken off the lug boxes and since lug boxes hold a smaller quantity of tomatoes than do the larger, jumble-packed containers, more motions are used to dump an equivalent amount of tomatoes from lug boxes than from the larger containers. The amount of labor required to dump tomatoes from the

TABLE 7. —Comparative efficiency and cost of direct labor for supplying containers of tomatoes to sorting line, in 14 tomato prepackaging plants in 10 eastern and midwestern cities, according to method used, based on 1 week of observation, February-June 1950

Method of supplying containers of tomatoes to sorting line	Plants surveyed	Quantity of tomatoes sorted	Man-hours of labor per 100 pounds sorted	Labor cost		Average distance tomatoes were moved in plants	Man-hours of labor per 100 pounds sorted per 100 ft. of average distance moved	Labor cost per 100 pounds sorted per 100 ft. of average distance moved
				Average hourly wage rate	Per 100 pounds sorted			
	Number	100 pounds	Man-hours	Dollars	Cents	Feet	Man-hours	Cents
Method 1. Manual transfer.....	2	857.7	0.029	1.20	3.5	32	0.091	10.9
Method 2. Hauling on hand trucks.	2	1,498.0	.024	.75	1.8	39	.062	4.6
Method 3. Hauling on skids.....	5	5,185.7	.009	1.12	1.0	59	.015	1.7
Method 4. Placing on conveyors...	1	341.7	.021	1.10	2.3	30	.070	7.7
Method 5. Combined manual transfer and use of skids.....	1	625.1	.022	.85	1.9	87	.025	2.1
Method 6. Combined use of skids and conveyors.....	3	5,420.1	.018	.88	1.6	75	.024	2.1
Total or average.....	14	13,928.3	0.017	0.95	1.6	62	0.027	2.6

shipping containers into which they were received at the prepackaging plant and the labor required to dump tomatoes from containers into which they were sorted and ripened are shown in table 8.

Dumping tomatoes from lug boxes.--The average amount of direct labor required to dump tomatoes from the original lug boxes in which they were received was 0.025 man-hour a 100 pounds of tomatoes dumped.

Dumping tomatoes from larger, jumble-packed containers.--The average amount of direct labor required to dump tomatoes from the original large, jumble-packed containers in which they were received was 0.019 man-hour a 100 pounds of tomatoes dumped.

Dumping tomatoes from containers into which they have been sorted and ripened.--The amount of labor required to dump tomatoes from containers--usually lug boxes--into which they had been previously sorted and then ripened averaged 0.031 man-hour a 100 pounds of tomatoes dumped.

To summarize, it is considerably more efficient to dump tomatoes from original large, jumble-packed containers than from original lug boxes. It was also more efficient to dump tomatoes from their original shipping containers than from containers into which they had been sorted and then ripened, because each of the latter containers normally held only about 20 pounds of tomatoes.

TABLE 8.—Comparative efficiency and cost of direct labor for dumping tomatoes in 14 tomato prepackaging plants based on 1 week of observation, in 10 selected eastern and midwestern cities, according to type of container, February-June 1950

Type of container from which tomatoes were dumped	Plants surveyed	Quantity of tomatoes dumped	Man-hours of labor per 100 pounds dumped	Labor cost	
				Average hourly wage rate	Per 100 pounds dumped
	<i>Number</i>	<i>100 pounds</i>	<i>Man-hours</i>	<i>Dollars</i>	<i>Cents</i>
Initial dumpings of fresh receipts:					
Lug boxes.....	8	2,387.6	0.025	1.11	2.8
Larger, jumble-packed containers.....	9	3,790.3	.019	1.16	2.2
Total or average..	¹ 14	6,177.9	0.021	1.14	2.4
Re-dumpings of previously sorted tomatoes ²	14	7,161.5	.031	1.09	3.4
Total or average ² ...	14	13,339.4	0.026	1.11	2.9

¹ Number of plants totals more than 14 because in three plants fresh receipts of tomatoes were initially dumped from both lug boxes and larger, jumble-packed containers.

² An additional 58,890 pounds were sorted from one container into other containers and were not dumped onto the sorting conveyor belt.

Methods of Handling Empty Shipping Containers

Empty lug boxes that accumulate as the mature green tomatoes are dumped onto the sorting conveyor belt are distributed to sorting and tray-filling operators for immediate use. Containers not suitable for re-use and lug boxes not needed usually are stored in the repackaging plant.

Method 1.--Manual piling.--Manually transferring empty containers, a few at a time, and manually piling them where needed or in storage areas was found to be the least efficient method of handling empty shipping containers. In four plants where this method was used, an average of 0.013 man-hour was required to handle empty containers for each 100 pounds of tomatoes sorted (table 9).

Method 2.--Hauling on skids.--The second most efficient method of handling empty shipping containers consisted of stacking them on skids and hauling the loaded skids to where they were needed or to storage areas. At the six plants using this method, an average of 0.012 man-hour was required for each 100 pounds of tomatoes sorted.

Method 3.--Placing on conveyors.--Stacking empty shipping containers on conveyors that carried them where they were needed or to storage areas was the most efficient method of handling empty containers. In the three plants where this method was used, an average of 0.010 man-hour was required to handle empty containers for each 100 pounds of tomatoes sorted.

Method 4.--Combined manual piling and use of conveyors.--In one plant, empty containers were transported on conveyors, although they were assembled and dispersed manually at each end of the conveyors. This was the least efficient of the four methods studied, requiring an average of 0.031 man-hour for each 100 pounds of tomatoes sorted. It should be noted, however, that this method was used in only one plant and therefore may not be a typical example.

In general, most of the empty shipping containers handled in the surveyed plants were lug boxes from which tomatoes were dumped and into which part of these

TABLE 9.—Comparative efficiency and cost of direct labor for handling empty containers in 10 eastern and midwestern cities, according to method used, based on 1 week of observation in each plant, February-June 1950

Method of handling empty containers	Plants surveyed	Quantity of tomatoes sorted	Man-hours of labor per 100 pounds sorted	Labor cost	
				Average hourly wage rate	Per 100 pounds sorted
	<i>Number</i>	<i>100 pounds</i>	<i>Man-hours</i>	<i>Dollars</i>	<i>Cents</i>
Method 1. Manual piling....	4	1,988.5	0.013	0.86	1.1
Method 2. Stacking on skids.....	6	6,694.0	.012	1.07	1.3
Method 3. Placing on conveyors.....	3	3,468.7	.010	1.02	1.0
Method 4. Combined manual piling and use of conveyors.....	1	1,777.1	.031	1.05	3.3
Total or average.....	14	13,928.3	0.014	1.03	1.4

tomatoes were immediately re-sorted. This resulted in a fairly continuous flow of empty containers from the dumping station to the sorting stations. The use of conveyors appeared to be the best method for handling this flow. The use of skids, manual piling, and the combined use of skids and manual piling proved to be less efficient methods of handling empty shipping containers.

Stripping Practices

Five of the 14 plants surveyed received their shipments of mature green tomatoes exclusively in lug boxes during the weeks they were surveyed, and three other plants also received part of their tomatoes in lug boxes. All of these plants followed the practice of stripping these tomatoes, that is, the operators manually loosened the paper wrappers from the tomatoes to facilitate their removal by a suction type blower located a few inches above the surface of the sorting conveyor belt. In these eight plants, a total of 152 man-hours was required to loosen wrappers during the stripping operation. This amounted to 0.064 man-hour for each 100 pounds of tomatoes dumped (table 10). At an average wage rate of \$1.03 an hour in these plants, the average direct labor cost for this operation amounted to 6.6 cents for each 100 pounds of tomatoes dumped.

Six of the 14 plants received all their mature green tomatoes in larger, jumble-packed containers during the time they were surveyed and three other plants received part of their tomatoes in these containers. No direct labor was required to strip the tomatoes received in the large, jumble-packed containers because these tomatoes were not wrapped.

TABLE 10.--Comparative efficiency and cost of direct labor for loosening wrappers in 14 tomato prepackaging plants in 10 eastern and midwestern cities, according to type of container from which tomatoes were dumped, based on 1 week of observation in each plant, February-June 1950

Type of container from which tomatoes were dumped	Plants surveyed	Quantity of tomatoes dumped	Man-hours of labor per 100 pounds dumped	Labor cost	
				Average hourly wage rate	Per 100 pounds dumped
	<i>Number</i>	<i>100 pounds</i>	<i>Man-hours</i>	<i>Dollars</i>	<i>Cents</i>
Initial dumpings of fresh receipts:					
Lug boxes.....	8	2,387.6	0.064	1.03	6.6
Larger, jumble-packed containers.....	9	3,790.3	--	--	--
Total or average..	¹ 14	6,177.9	0.025	1.03	2.6
Redumping of previously sorted tomatoes.....	14	7,750.4	² .001	1.03	² .001
Total or average..	14	13,928.3	0.011	1.03	1.1

¹ Number of plants totals more than 14 because in three plants fresh receipts of tomatoes were initially dumped from both lug boxes and larger, jumble-packed containers.

² At five of the plants in which tomatoes were dumped from the larger, jumble-packed containers, 5.15 man-hours of labor were used to bale or sack wrappers that had been stripped from tomatoes sorted before these plants were surveyed.

Methods of Sorting

Method 1.--Sorting from one container into other containers.--Tomatoes have to be sorted into lots of similar qualities and stages of ripeness. Of the four methods of sorting tomatoes studied, the least efficient method involved sorting tomatoes from the container in which they were stored in the ripening rooms into other containers placed around it. In two plants which used this completely manual method of sorting tomatoes, an average of 0.202 man-hour of direct labor was required to sort 100 pounds of tomatoes (table 11).

Method 2.--Sorting from conveyor belt into containers.--By this method, tomatoes were dumped onto the sorting conveyor belt, and operators stationed along both sides of the belt sorted the tomatoes into containers, usually lug boxes, placed either on benches alongside the belt or on low tables set astride the belt. Tomatoes of the most prevalent stage of ripeness, usually mature green, were allowed to pass to the end of the belt, from which they dropped into containers attended by sorting operators. In 10 plants that used this method of sorting tomatoes an average of 0.154 man-hour of direct labor was required to sort 100 pounds of tomatoes. This method was about one-third more efficient than the completely manual method.

Method 3.--Sorting from conveyor belt into bins.--The second most efficient method of sorting also made use of a conveyor belt. Operators stationed along one side of this belt sorted ripe, packageable tomatoes into bins adjoining the other side of the belt. As in method 2, tomatoes not ripe enough for prepackaging were sorted into containers, and the mature green tomatoes were collected in containers at the end of the belt. In five plants using method 3, an average of 0.143 man-hour of direct labor was required to sort 100 pounds of tomatoes. Sorting from belts into bins is not only more efficient than sorting from belts into containers, but it also eliminates the separate operation of supplying tomatoes to the packaging line.

TABLE 11.—Comparative efficiency and cost of direct labor for sorting tomatoes, in 14 tomato prepackaging plants in 10 eastern and midwestern cities, according to method used, based on 1 week of observation in each plant February-June 1950

Sorting method	Plants surveyed	Quantity of tomatoes sorted	Man-hours of labor per 100 pounds sorted	Labor cost	
				Average hourly wage rate	Per 100 pounds sorted
	<i>Number</i>	<i>100 pounds</i>	<i>Man-hours</i>	<i>Dollars</i>	<i>Cents</i>
Method 1. Sorting from one container into other containers.....	2	533.8	0.202	1.01	20.4
Method 2. Sorting from conveyor belt into containers..	10	7,393.1	.154	.94	14.5
Method 3. Sorting from conveyor belt into bins.....	5	2,728.4	.143	1.13	16.2
Method 4. Sorting from conveyor belt onto other conveyor belts.....	1	2,107.8	.085	1.12	9.5
Total or average.....	¹ 14	² 12,763.1	.142	1.00	14.2

¹ Number of plants totals more than 14 because some plants used more than one method.

² An additional 116,520 pounds of tomatoes were sorted for which neither man-hours nor cost data were obtained.

Method 4.--Sorting from conveyor belt onto other conveyor belts.--The most efficient method of sorting made use of two narrow conveyor belts tiered above the center of a wider main conveyor belt. Tomatoes were dumped onto the end of the main conveyor belt, and operators stationed along both sides of this belt either placed the tomatoes onto one of the two narrow conveyor belts, or allowed them to pass down the main belt according to their stage of ripeness. If the most prevalent stage of ripeness of the tomatoes was mature green, these tomatoes were allowed to pass to the end of the main conveyor belt, and tomatoes of an intermediate stage of ripeness were placed on the lower of the two narrow belts, and the ripe packageable tomatoes were placed on the top belt. The green tomatoes were collected at the end of the main conveyor belt into bins which were mechanically emptied into containers by operators using foot treadles that lowered a gate at the back end of each bin. At the end of each narrow belt was a collecting trough through which tomatoes from the narrow belt were emptied into containers attended by operators. If most of the tomatoes were ripe enough for packaging, the sorting usually was performed on another similar piece of equipment, except that the ripe, packageable tomatoes were allowed to pass to the end of the main conveyor belt and the green tomatoes were placed on the top narrow belt. The ripe, packageable tomatoes rolled from the main conveyor belt onto another conveyor belt from which they were mechanically distributed into bins for use by those who filled the trays. Only one plant was found to be using this method. Here an average of 0.085 man-hour of direct labor was used for sorting each 100 pounds of tomatoes sorted. This method was considerably more efficient in the use of man-hours of direct labor than methods 2 and 3, and more than twice as efficient as method 1.

Of the four methods studied, the most efficient, as evaluated in only one plant, was sorting from belts onto other belts. The next most efficient method, which was used in five plants, involved sorting from a conveyor belt into bins. Although sorting from belts into containers was found to be used by the majority of the plants, it was not so efficient as sorting from belts onto other belts or into bins.

Methods of Removing Containers of Unripe Tomatoes to Ripening Rooms

Method 1.--Manual removal.--After each sorting, containers of tomatoes not ripe enough for packaging were removed to ripening rooms or storage areas. Of the six methods studied, the third most efficient method of performing this operation consisted of manually removing containers of unripe tomatoes, one or two at a time, from the sorting line to ripening areas. Only one plant used this method. Here an average of 0.046 man-hour of direct labor was required to move containers of unripe tomatoes a distance of 100 feet, for each 100 pounds of tomatoes sorted (table 12). Although it might logically be expected that this method would be least efficient in the use of direct labor, there is the possibility that it may be efficient in plants where the distance between the sorting conveyor belt and the ripening area is but a few steps, as was the case in this plant.

Method 2.--Hauling on hand trucks.--One of the less efficient methods of removing unripe tomatoes from the sorting line to the ripening rooms consisted of collecting filled containers of these tomatoes on hand trucks. The loaded hand trucks were then taken to the ripening rooms and unloaded, one container at a time, onto the ripening-room floor. At two plants using this method, the removal of unripe tomatoes over a distance of 100 feet required an average of 0.128 man-hour for each 100 pounds sorted.

Method 3.--Hauling on skids.--The most efficient of the six methods studied involved the use of skids for hauling containers of unripe tomatoes from the sorting line to the ripening rooms. The skids were loaded at or near the sorting line and then taken to the ripening rooms where they were deposited intact. In six plants where this method was used, an average of 0.020 man-hour was required to move the tomatoes over a distance of 100 feet for each 100 pounds of tomatoes sorted. The use

TABLE 12.—Comparative efficiency and cost of direct labor for removing containers of unripe tomatoes from sorting line to ripening rooms, in 14 tomato repackaging plants in 10 eastern and midwestern cities, according to method used, based on 1 week of observation, in each plant, February-June 1950

Method of removing containers of unripe tomatoes to ripening rooms	Plants surveyed	Quantity of tomatoes sorted	Man-hours of labor per 100 pounds sorted	Labor cost		Average distance tomatoes were moved in plants	Man-hours of labor per 100 pounds sorted per 100 feet of average distance moved	Labor cost per 100 pounds sorted per 100 feet of average distance moved
				Average hourly wage rate	Per 100 pounds sorted			
	Number	100 pounds	Man-hours	Dollars	Cents	Feet	Man-hours	Cents
Method 1. Manual removal.....	1	381.5	0.006	1.56	0.9	13	0.046	7.2
Method 2. Hauling on hand trucks..	2	1,498.0	.037	.75	2.8	29	.128	9.6
Method 3. Hauling on skids.....	6	5,810.8	.018	.97	1.7	88	.020	1.9
Method 4. Placing on conveyors....	2	1,876.9	.037	.90	3.3	49	.076	6.8
Method 5. Combined manual removal and use of conveyors.....	1	476.2	.070	1.10	7.7	32	.219	24.1
Method 6. Combined use of skids and conveyors.....	2	3,884.9	.026	.95	2.5	90	.029	2.8
Total or average.....	14	13,928.3	.026	.93	2.4	73	.036	3.3

of skids was more than twice as efficient in the use of direct labor as was the use of hand trucks (method 2), probably because the containers of tomatoes they carried did not have to be individually unloaded and stacked on the ripening-room floor. Similar savings in direct labor occurred when the skidloads of tomatoes were later removed intact from the ripening rooms to the sorting line for additional sorting.

Method 4.--Placing on conveyors.--Conveyor systems were used in two plants to remove unripe tomatoes from the sorting line to the ripening rooms. The filled containers were placed on conveyors running parallel to the sorting conveyor belt and within easy reach of the sorting stations. These conveyors extended into the ripening rooms, where operators unloaded and stacked them. In the two plants that used this method, an average of 0.076 man-hour was required to remove the unripe tomatoes through 100 feet of distance from sorting line to ripening rooms, for each 100 pounds of tomatoes sorted.

Method 5.--Combined manual removal and use of conveyors.--The least efficient of the six methods studied consisted of a combination of manual and conveyor removal. Containers of unripe tomatoes were first stacked temporarily near the sorting conveyor and were later sent to the ripening rooms on conveyors. At the one plant in which this method was used, an average of 0.219 man-hour was required to move the unripe tomatoes 100 feet for each 100 pounds of tomatoes sorted.

Method 6.--Combined use of skids and conveyors.--The second most efficient method of removing containers of unripe tomatoes from the sorting line to the ripening rooms involved the use of both skids and conveyors. This method was used in one plant because most of the ripening room space could not easily be reached by conveyors. In another plant in which this method was used, the filled containers were moved from the sorting line by gravity conveyors to a power conveyor that transferred the tomatoes to the floor above. They were then stacked on skids and moved into the ripening rooms, which were all located on that floor. At these two plants, an average of 0.029 man-hour of direct labor was required to move the tomatoes 100 feet for each 100 pounds sorted.

Effect of building layout on efficiency.--The preceding discussion relates to the efficiency of direct labor used to remove unripe tomatoes from the sorting line to the ripening rooms by various methods as measured in terms of man-hours of direct labor for each 100 pounds of tomatoes sorted for each 100 feet of distance the tomatoes were moved. It did not take into account the fact that the plan of a building, among other factors, affects the layout of the plant equipment and the desirability of using a particular method of transporting tomatoes from the sorting belt to the ripening rooms. In terms of man-hours of direct labor required to move the tomatoes from the sorting line to the ripening rooms for each 100 pounds of tomatoes sorted, and disregarding the distance through which the tomatoes were moved, method 1 was most efficient because of the proximity of the sorting line to the ripening rooms. The average number of man-hours of direct labor required for 100 pounds sorted was 0.006 for method 1, 0.018 for method 3, 0.026 for method 6, 0.037 for both methods 2 and 4, and 0.070 for method 5.

In general, therefore, it would appear that the use of skids provides the most efficient method of transferring unripe tomatoes to the ripening rooms. Conveyors and hand trucks are less efficient, although, as in the case of the manual transfer method, certain peculiarities in a plant's layout may necessitate recommending their use.

Methods of Supplying Ripe Tomatoes to Packaging Line

Method 1.--Manual transfer in containers.--Tomatoes ripe enough to be packaged were transferred from the sorting line to the packaging line by five methods in the 14 plants surveyed. The least efficient method of performing this operation was the manual transfer of individual containers of tomatoes. In one plant where this method was used, an average of 0.950 man-hour was required to move the equivalent of

100 trays of prepackaged tomatoes 100 feet between the sorting and packaging lines (table 13). In this plant the sorting and packaging lines were parallel to each other and only about 6 feet apart. It probably would have resulted in a more efficient use of direct labor if the sorting and packaging lines were moved closer together and the tomatoes were sorted directly into bins set up between them.

Method 2.--Hauling containers on hand trucks.--Another inefficient method of transferring ripe tomatoes from the sorting line to the packaging line involved stacking filled containers on hand trucks at the sorting line, hauling them to the packaging line, removing the containers from the hand trucks, and placing them within reach of the tray-filling operators. At two plants where hand trucks were used, an average of 0.444 man-hour of direct labor was required to move the equivalent of 100 trays of prepackaged tomatoes 100 feet.

Method 3.--Hauling containers on skids.--This was a method whereby skids were loaded with containers of ripe tomatoes at the sorting line, hauled to within easy reach of the tray-filling operators, and deposited intact. The tray-filling operators removed the containers as needed. Because it was not necessary to unload the skids at the tray-filling stations, as was required in other methods, such as using hand trucks or conveyors, the use of skids was more efficient than any other method except sorting directly into the tray-fillers' bins. At four plants that used this method, an average of 0.071 man-hour of direct labor was required to move the equivalent of 100 trays of tomatoes 100 feet.

Method 4.--Placing containers on conveyors.--A conveyor system was used in one plant to transfer ripe tomatoes from the sorting line to the packaging line. Sorting operators placed filled containers on a conveyor leading to the packaging line. A special operator was required to remove the tomatoes from this conveyor and place them on benches for use by the tray-filling operators. This method required 0.082 man-hour of direct labor to move the equivalent of 100 trays of prepackaged tomatoes 100 feet.

Method 5.--Sorting tomatoes into tray-fillers' bins.--The most efficient method of transferring ripe tomatoes from the sorting line to the packaging line involved the use of two conveyor belts, one used for sorting tomatoes and the other for filling trays. These conveyor belts were placed parallel to each other and separated by a row of bins. Sorting operators along one side of the sorting conveyor belt sorted all ripe, packageable tomatoes directly into the bins. In one plant, a variation of this method was used. The bins and the tray-filling conveyor belt, although parallel to the sorting conveyor belt, were not directly opposite the sorting conveyor belt, but began instead where the latter belt ended. Packageable tomatoes from the sorting conveyor belt passed onto another conveyor belt from which they were mechanically distributed into the bins. Regardless of whether the packageable tomatoes were placed in the bins manually or mechanically, the distance that these tomatoes were moved by hand was negligible, and, except for small amounts of labor sometimes used to dump containers of ripe tomatoes directly into the tray-fillers' bins, the labor used to transfer packageable tomatoes from the sorting line to the packaging line was merged with the sorting and tray-filling operations. As a result, there was no measurable direct labor cost for this operation.

The arrangement of equipment in the plant, particularly the distance between sorting line and packaging line, affected the efficiency of the direct labor used in all the methods. This arrangement itself was influenced by the type of construction of the building used, among other factors. However, disregarding the distance that the tomatoes were moved, method 5 was still the most efficient one, since sorters themselves, as part of the sorting operation, performed the operation of supplying ripe tomatoes to the tray fillers. They did this merely by sorting the ripe tomatoes either directly or indirectly into the tray-fillers' bins instead of, as in the other methods, into containers that had to be carried to the tray fillers. The number of man-hours of labor required for each 100 trays of tomatoes prepackaged--disregarding

TABLE 13. — Comparative efficiency and cost of direct labor for supplying ripe tomatoes to packaging line, in 14 tomato repackaging plants in 10 eastern and midwestern cities, according to method used, based on 1 week of observation in each plant, February-June 1950

Method of supplying ripe tomatoes to packaging line	Plants surveyed	Quantity of tomatoes pre-packaged	Man-hours of labor per 100 pre-packaged	Labor cost		Average distance tomatoes were moved	Man-hours of labor per 100 trays pre-packaged per 100 ft. of average distance tomatoes were moved	Labor cost per 100 trays pre-packaged per 100 feet of average distance tomatoes were moved
				Average hourly wage rate	Per 100 trays pre-packaged			
	Number	100 trays	Man-hours	Dollars	Cents	Feet	Man-hours	Cents
Method 1. Manual transfer in containers.....	1	326.5	0.057	1.10	6.3	6	0.950	104.5
Method 2. Hauling containers on hand trucks.....	2	1,676.9	.071	.98	7.0	16	.444	43.5
Method 3. Hauling containers on skids.....	4	1,279.8	.039	.81	3.2	55	.071	5.8
Method 4. Placing containers on conveyors.....	1	665.4	.064	.90	5.8	78	.082	7.4
Method 5. Sorting tomatoes into tray-fillers' bins ¹	6	3,584.6	.003	1.11	0.3	--	--	--
Total or average.....	14	7,533.2	0.032	.95	3.0	20	0.160	15.2

¹ Since the tomatoes were sorted directly into the bins during the sorting operation, no labor was charged to this operation except for the negligible amounts of labor that were infrequently required to dump containers of ripe tomatoes directly into the tray-fillers' bins. The distance that these containers of tomatoes were moved was not measured.

the effect of variation in distance that the tomatoes were moved -- was 0.003 for method 5, which accounts for the small amounts of labor occasionally used to dump containers of ripe tomatoes directly into the tray-fillers' bins; 0.039 for method 3; 0.057 for method 1; 0.064 for method 4; and 0.071 for method 2.

Generally, therefore, it appears that sorting tomatoes into the tray-fillers' bins is the most efficient method of supplying ripe tomatoes to the packaging line, provided that the necessary arrangement of sorting belt, bins, and tray-filling conveyor belt is possible. If such an arrangement is not possible, hauling containers of tomatoes on skids from the sorting to the packaging line appears the most efficient method. Manual transfer or the use of hand trucks or conveyors would appear to be less efficient uses of direct labor.

Methods of Setting Up and Filling Trays

Method 1.--Complete filling and closing of window carton-type trays. --In the two plants where this method was used, a special operator manually set up knocked-down, window carton-type trays. Each tray-filling operator then completely filled and closed each tray. No overwrapping machines are necessary when these window carton-type trays are used. In the two plants where this method was used, an average of 0.617 man-hour of direct labor was required for setting up, filling, and closing 100 trays of tomatoes (table 14). It was the least efficient method of filling trays that was observed except for the method used in the one plant where each package of tomatoes was weighed.

Method 2.--Complete tray-filling from lug boxes on benches adjacent to conveyor belt. --In two plants that used this method the trays were set up manually by tray-filling operators at individual benches along either or both sides of a conveyor belt. These benches were supplied with knocked-down trays and with lug boxes of tomatoes to be packaged. Each operator manually set up a knocked-down tray, filled it with tomatoes, and placed it on the adjacent conveyor belt, which carried it toward an overwrapping machine. In the two plants employing this method, an average of 0.402 man-hour of direct labor was required for setting up and filling 100 trays.

In another plant that used this method the trays were set up mechanically. A tray set-up machine was attended by an operator who supplied the tray-filling benches with containers of set-up trays. The trays were filled by the tray-filling operators and placed on an adjacent conveyor belt leading toward an overwrapping machine. In this plant an average of 0.381 man-hour of direct labor was required to set up and fill 100 trays.

The average direct labor requirement in all three plants using method 2, regardless of how the trays were set up, was 0.395 man-hour for each 100 trays set up and filled.

Method 3.--Partial tray filling from bins alongside conveyor belt. --Seven plants used this method of filling trays with tomatoes. A crew of tray-filling operators faced a conveyor belt that carried empty trays. Each operator picked up tomatoes from bins on the other side of this belt and placed only one or two tomatoes into any one tray. To maintain efficiency, it was found desirable to use uniformly sized tomatoes with this method; otherwise the operators would slow down the packaging line in fitting the last tomato into each package. The filled trays were then fed by the conveyor belt into an overwrapping machine. In these seven plants, an average of 0.252 man-hour was required for each 100 trays set up and filled.

In two of the seven plants, a special operator manually set up knocked-down trays and fed them onto the conveyor belt. An average of 0.301 man-hour was required at these two plants to set up and fill 100 trays.

TABLE 14.—Comparative efficiency and cost of direct labor for setting up and filling consumer packages with tomatoes, in 14 prepackaging plants in 10 eastern and midwestern cities, according to method used, based on 1 week of observation in each plant, February-June 1950

Method of setting up and filling trays	Plants surveyed	Quantity of trays set up and filled	Man-hours of labor per 100 trays set up and filled	Labor cost	
				Average hourly wage rate	Per 100 trays set up and filled
	<i>Number</i>	<i>100 trays</i>	<i>Man-hours</i>	<i>Dollars</i>	<i>Cents</i>
Method 1. Complete filling and closing of window carton-type trays.....	2	209.5	0.617	0.86	53.1
Method 2. Complete tray filling from lug boxes on benches adjacent to conveyor belt:					
Trays set up manually.....	2	1,600.8	.402	1.20	48.2
Trays set up mechanically...	1	665.4	.381	.90	34.3
Total or average.....	3	2,266.2	.395	1.11	43.8
Method 3. Partial tray-filling from bins along-side conveyor belt:					
Trays set up manually.....	2	712.2	.301	.97	29.2
Trays set up mechanically...	3	2,076.6	.231	1.18	27.3
Trays set up both manually and mechanically.....	2	502.6	.272	1.01	27.5
Total or average.....	7	3,291.4	.252	1.09	27.5
Method 4. Complete tray-filling from bins along-side conveyor belts:					
Trays set up mechanically...	1	397.8	.266	.75	20.0
Trays set up both manually and mechanically.....	1	891.0	.368	1.20	44.2
Total or average.....	2	1,288.8	.337	1.09	36.7
Method 5. Complete tray-filling and weighing from bins along-side conveyor belt:					
Trays set up both manually and mechanically.....	1	477.3	.680	1.00	68.0
Total or average.....	¹ 14	7,533.2	.347	1.08	37.5

¹ Number of plants totals 15 because one plant used two methods.

In three of the seven plants that used method 3 the trays were set up mechanically and automatically fed onto the conveyor belt. In these three plants an average of 0.231 man-hour was required to set up and fill 100 trays.

In two plants trays were set up by either a special operator or a tray set-up machine and were fed onto the tray-filling conveyor belt. In these two plants, an average of 0.272 man-hour was required to set up and fill 100 trays.

Method 4.--Complete tray-filling from bins alongside conveyor belt.--Two plants used this method, which differed from method 3 in that each tray-filling operator completely filled a tray after lifting it from the tray-filling conveyor belt and then returned it to the belt. In these two plants, an average of 0.337 man-hour was required per 100 trays set up and filled.

In one of these two plants, where a tray set-up machine was used to set up trays and feed them onto the tray-filling conveyor belt, an average of 0.266 man-hour of direct labor was required to set up and fill 100 trays.

In the other of the two plants using method 4, part of the trays were set up by the operators themselves, and part were set up mechanically and automatically fed onto the conveyor belt. In this plant an average of 0.368 man-hour was required to set up and fill 100 trays.

Method 5.--Complete tray-filling and weighing from bins alongside conveyor belt.--In one plant, part of the trays were set up by tray-filling operators, and part were set up mechanically and supplied the tray-filling operators by a special operator who attended the tray set-up machine. Each tray-filling operator completely filled each tray, as in method 4, and then weighed the tray after filling it. An average of 0.680 man-hour was required to set up, fill, and weigh 100 trays in this plant.

The comparative efficiency of setting up trays by three different methods was studied as a separate operation in seven plants. The most efficient method was (1) the method whereby trays were mechanically set up and automatically fed onto the tray-filling conveyor belt. At five plants using this method, an average of 0.028 man-hour of direct labor was required to set up 100 trays. Less efficient methods were (2) mechanically setting up trays and manually distributing them to each operator's tray-filling station, which required an average of 0.031 man-hour for each 100 trays set up, and (3) manually setting up the trays and feeding them onto the tray-filling conveyor belt, which required an average of 0.056 man-hour for each 100 trays set up.

Partial tray filling from bins alongside a conveyor belt was the most efficient method of filling trays. Complete tray filling from bins alongside a conveyor belt was the next most efficient method. Both of these methods were performed most efficiently when the trays were mechanically set up and fed onto the tray-filling conveyor belt. Complete tray-filling at benches adjacent to a conveyor belt and complete filling and closing of window carton-type trays were the least efficient methods of filling trays. However, filling and closing window carton-type trays did not require the use of expensive overwrapping machinery.

Use of Alternative Types of Overwrapping Machines

Overwrapping machines, used in all but one of the 14 plants surveyed, required occasional attention from operators. The usual operations included starting and stopping, servicing, replenishing or changing overwrapping film, observing the machine for faulty operation, etc. A total of 23 machines was found in the 14 plants. Six plants used the faster more costly type of machine, and each of four of the six plants was equipped with two of these machines. These machines were operated at speeds ranging between 62 and 90 packages a minute, with a median speed of 75 packages a minute. The f.o.b. cost of each of them, new, was about \$4,000. Of the

two types (slow and fast), the faster machine used less direct labor for a given quantity of output, requiring an average of 0.019 man-hour of direct labor for each 100 trays overwrapped (table 15). At an average hourly rate of \$1.12, this direct labor cost 2.1 cents for each 100 trays prepackaged.

A less costly type of overwrapping machine was used in seven plants, and all but one of them were equipped with two machines each. This type machine was less efficient in the use of direct labor, requiring 1-1/2 times as many man-hours of attention for a given quantity of output. These machines were operated in the seven plants at speeds ranging between 37 and 50 packages a minute, with a median speed of 41 packages a minute. The f.o.b. cost of each of these machines, new, was about \$2,500. An average of 0.029 man-hour of direct labor for each 100 trays overwrapped was required to operate these machines. At an hourly rate of \$1.01, this amounted to 2.9 cents direct labor cost per 100 trays.

The slower overwrapping machine generally requires about as much attention as the faster machine, despite their different rates of output, which accounts for the difference in the efficiency of labor used for their operation. Probably one of the most important factors affecting the choice of overwrapping machines is the volume of operation. Obviously, it would be inefficient to install the faster, more costly type of machine in a plant handling such a small volume that the machine would be idle a considerable part of the time. As shown in table 15, the plants with the larger volume generally used the faster machine, as their average weekly production amounted to approximately 81,000 trays as compared with only 35,000 trays in the plants using the slower and less costly overwrapping machines.

Methods of Setting Up, Filling, and Closing Master Shipping Containers

One-piece self-locking box holding 10 trays--manually set-up, filled, and closed.-- As consumer packages of tomatoes emerged from the overwrapping machine, they were placed in a master shipping container, usually a fiberboard box, for shipment from the plant. About 46 percent of the tomatoes prepackaged at the plants surveyed were placed in single-layer, one-piece self-locking boxes, each holding 10 consumer packages. This operation consisted of (1) procuring a box blank from a nearby stack, (2) setting it up by folding over its flaps and by locking tabs on these flaps into appropriate slots in the blank, (3) delivering a quantity of set-up boxes to the box-

TABLE 15.—Comparative efficiency and cost of direct labor for operating overwrapping machines, in 14 tomato prepackaging plants in 10 eastern and midwestern cities, according to type of machine operated, based on 1 week of observation in each plant, February-June 1950

Type of machine	Plants surveyed	Quantity of tomatoes pre-packaged	Man-hours of labor per 100 trays prepackaged	Labor cost	
				Average hourly wage rate	Per 100 trays pre-packaged
	<i>Number</i>	<i>100 trays</i>	<i>Man-hours</i>	<i>Dollars</i>	<i>Cents</i>
Faster, more costly machine.....	6	4,851.4	0.019	1.12	2.1
Slower, less costly machine.....	7	2,472.3	.029	1.01	2.9
Total or average.....	¹ 13	¹ 7,323.7	.022	1.08	2.4

¹ An additional 20,950 trays were prepackaged in window carton-type trays. One of the surveyed plants was not equipped with an overwrapping machine.

filling station of a packaging line, (4) filling each box with packaged tomatoes, (5) closing the box by folding over its attached lid and tucking in its flaps, and (6) stacking the filled, closed box on a skid or hand truck at the box-filling station. At 5 plants where one-piece self-locking boxes were used, the average amount of direct labor required to set up, fill, and close 10 of these containers, which held 100 trays, was 0.100 man-hour. At an average hourly rate of \$1.00, the direct labor cost for each 10 boxes set up, filled, and closed was 10.0 cents (table 16).

Two-piece telescope box holding 10 trays--machine stitched and manually filled and closed.--Twenty-five percent of tomatoes prepackaged at the plants surveyed were placed in single-layer, two-piece telescope boxes, each consisting of a separate fiberboard bottom and lid and each holding 10 consumer packages of tomatoes. The procedure for setting up, filling, and closing these boxes consisted of (1) procuring a blank for either a bottom or a lid, both of which were of similar design and were set up in a similar manner, (2) setting each box up by stitching its corners on a wire stitching machine, (3) delivering a quantity of set-up bottoms and lids to the box-filling station on a packaging line, (4) filling each bottom with consumer packages of tomatoes, (5) closing the box by placing a lid over the filled bottom, and (6) stacking the filled, closed box on a skid or hand truck at the box-filling station. Two-piece telescope boxes, on the average, required 23 percent more direct labor to set up, fill, and close than did one-piece self-locking boxes. At two plants using two-piece telescope boxes, an average of 0.123 man-hour of direct labor was required to set up, fill, and close 10 of them. At an average hourly rate of \$1.09, the direct labor cost per 10 containers set up, filled, and closed amounted to 13.4 cents. However, the difference between the average direct labor costs for setting up, filling, and closing one-piece self-locking boxes and two-piece telescope boxes was more than offset by the fact that the former were about 1 cent more costly a box than the latter.

TABLE 16.--Comparative efficiency and cost of direct labor for setting up, filling, and closing master shipping containers for prepackaged tomatoes, in 14 prepackaging plants in 10 eastern and midwestern cities, according to type of container used and methods of setting up and closing, based on 1 week of observation in each plant, February-June 1950

Type of master shipping container and method of setting up and closing	Plants surveyed	Quantity tomatoes pre-packaged	Man-hours of labor per 100 trays prepackaged	Labor cost	
				Average hourly wage rate	Per 100 trays prepackaged
	<i>Number</i>	<i>100 trays</i>	<i>Man-hours</i>	<i>Dollars</i>	<i>Cents</i>
One-piece self-locking box holding 10 trays--manually set up, filled and closed...	5	3,422.4	0.100	1.00	10.0
Two-piece telescope box holding 10 trays--machine stitched and manually filled and closed.....	2	1,885.7	.123	1.09	13.4
Two-piece telescope box holding 10 trays--purchased set up and manually filled and closed.....	2	330.6	.063	1.60	10.1
Miscellaneous types of master shipping containers ¹	5	1,894.5	.092	.96	8.8
Total or average.....	14	7,533.2	.102	1.03	10.5

¹ Miscellaneous types of master shipping containers were used in these plants, including lug boxes, various types of fiberboard boxes, etc. The man-hours used for setting up, filling, and closing each type of container were not measured.

Two-piece telescope box holding 10 trays--purchased set-up and manually filled and closed.--At two plants where two-piece telescope boxes were purchased set-up, an average of 0.063 man-hour of direct labor was required to manually fill and close 10 boxes. At an average hourly rate of \$1.60, the cost of this labor amounted to 10.1 cents for each 10 boxes manually filled and closed. Only 4 percent of the tomatoes prepackaged at the plants surveyed were placed in two-piece telescope boxes purchased set-up.

Miscellaneous types of master shipping containers.--The remaining 25 percent of the tomatoes prepackaged at the plants studied were placed in other types of master shipping containers, including double-layer fiberboard boxes--each holding 20 consumer packages, regular slotted cartons, lug boxes, etc.

To summarize, it was found more efficient to set up, fill, and close the one-piece self-locking box than the two-piece telescope box. However, two plants used two-piece telescope boxes that had been purchased already set up, and less labor was required to fill and close them than to set up, fill, and close other types of containers. The choice of a container is probably influenced by a number of factors in addition to the labor required to set up, fill, and close it. Other factors would include the original cost of the container, re-use value, trade acceptance, and the cost and expense of operating auxiliary equipment, such as an electric stapling machine.

Methods of Removing Full Master Shipping Containers

Master shipping containers filled with prepackaged tomatoes were stacked by the box-filling operators on skids or hand trucks at the box-filling station of the packaging line. Skids or hand trucks were used at all 14 plants for removing full containers of prepackaged tomatoes destined for selling, shipping, or holding areas, and the tomatoes almost invariably remained on this equipment until shipped from the plant. The comparative efficiency of using these two types of equipment was not determined. At all 14 plants, an average of 0.030 man-hour of direct labor was required to remove full master shipping containers for each 100 trays of tomatoes prepackaged. At an average hourly rate of \$1, the direct labor cost amounted to 3 cents for each 100 trays of prepackaged tomatoes.

Summary of Direct Labor Requirements and Costs for all Operations

It cost an average of \$1.05 for direct labor for each 100 trays of tomatoes prepackaged in the 14 surveyed plants. This was based on a labor requirement of 1.02 man-hours at an average hourly rate of \$1.03. The comparative efficiencies and costs of direct labor used to prepackage tomatoes according to the various methods and practices of performing specified operations in the 14 plants are shown in table 17. The three most costly operations were (1) tray filling, (2) sorting, and (3) setting up, filling, and closing master shipping containers. These operations alone accounted for almost 70 percent of all the direct labor used in the 14 plants. The remaining 30 percent of the direct labor was used for such operations as dumping, loosening wrappers, handling empty containers, and operating overwrapping machines.

Direct labor costs to perform specific operations varied widely, the variance depending primarily on the method used to perform the operation. For example, direct labor cost for completely filling and closing 100 window, carton-type trays averaged 53.1 cents, whereas partial tray filling from bins alongside a conveyor belt cost on the average only 27.5 cents for each 100 trays filled. Likewise, sorting tomatoes from one container into other containers was found to cost an average of 37.7 cents for each 100 trays prepackaged, as compared with 17.6 cents for sorting tomatoes from one conveyor belt onto other conveyor belts.

Of course, the costs for performing these operations by the various methods are for direct labor only, and do not take into account possible differences in costs of

TABLE 17.—Comparative efficiency and cost of direct labor for prepackaging tomatoes, in 14 prepackaging plants in 10 eastern and midwestern cities, according to methods and practices used in performing specified operations, based on 1 week of observation in each plant, February-June 1950

Operation and method of performance	Number of plants using specified method	Tomatoes prepackaged during week of observation	Man-hours of labor per 100 trays prepackaged	Labor cost per 100 trays prepackaged
Sorting and associated operations: ¹				
1. Supplying containers of tomatoes to sorting line:				
Method 1. Manual transfer.....	2	466.2	0.054	6.5
Method 2. Hauling on hand trucks.....	2	760.7	.044	3.3
Method 3. Hauling on skids.....	5	3,010.6	.017	1.8
Method 4. Placing containers on conveyors.....	1	138.5	.039	4.3
Method 5. Combined manual transfer and use of skids	1	286.8	.041	3.5
Method 6. Combined use of skids and conveyors.....	3	2,870.4	.033	3.0
Total or average.....	14	7,533.2	.031	3.0
2. Dumping tomatoes onto sorting conveyor belt.....	14	7,533.2	.046	5.1
3. Handling empty shipping containers:				
Method 1. Manual piling.....	4	1,053.7	.024	2.0
Method 2. Hauling on skids.....	6	3,609.7	.022	2.4
Method 3. Placing on conveyors.....	3	1,555.8	.018	1.8
Method 4. Combined manual piling and use of conveyors.....	1	1,314.0	.057	6.1
Total or average.....	14	7,533.2	.026	2.6
4. Loosening wrappers from tomatoes.....	14	7,533.2	.020	2.0
5. Sorting:				
Method 1. Sorting from one container into other containers.....	2	249.1	.373	37.7
Method 2. Sorting from conveyor belt into containers.....	10	4,900.6	.285	26.8
Method 3. Sorting from conveyor belt into bins.....	5	1,492.5	.264	30.0
Method 4. Sorting from conveyor belt onto other conveyor belts.....	1	891.0	.157	17.6
Total or average.....	2 14	7,533.2	.263	26.3

See footnotes at end of table.

TABLE 17. —Comparative efficiency and cost of direct labor for prepackaging tomatoes, in 14 prepackaging plants in 10 eastern and midwestern cities, according to methods and practices used in performing specified operations, based on 1 week of observation in each plant, February-June 1950—Continued

Operation and method of performance	Number of plants using specified method	Tomatoes prepackaged during week of observation	Man-hours of labor per 100 trays prepackaged	Labor cost per 100 trays prepackaged
	<i>Number</i>	<i>100 trays</i>	<i>Man-hours</i>	<i>Cents</i>
Sorting and associated operations: ¹ —Continued				
6. Removing containers of unripe tomatoes to ripening rooms:				
Method 1. Manual removal.....	1	139.7	0.011	1.7
Method 2. Hauling on hand trucks.....	2	760.7	.068	5.2
Method 3. Hauling on skids.....	6	3,297.4	.033	3.1
Method 4. Placing on conveyors.....	2	803.9	.068	6.1
Method 5. Combined manual removal and use of conveyors.....				
Method 6. Combined use of skids and conveyors.....	1	326.5	.129	14.2
	2	2,205.0	.048	4.6
Total or average.....	14	7,533.2	.048	4.4
Total or average.....	14	7,533.2	.434	43.4
Tray-filling and associated operations:				
7. Supplying ripe tomatoes to packaging line:				
Method 1. Manual transfer in containers.....	1	326.5	.057	6.3
Method 2. Hauling containers on hand trucks.....	2	1,676.9	.071	7.0
Method 3. Hauling containers on skids.....	4	1,279.8	.039	3.2
Method 4. Placing containers on conveyors.....	1	665.4	.064	5.8
Method 5. Sorting tomatoes into tray-fillers bins	6	3,584.6	.003	0.3
Total or average.....	14	7,533.2	.032	3.0
8. Setting up and filling trays:				
Method 1. Complete filling and closing of window, carton-type trays.....	2	209.5	.617	53.1
Method 2. Complete tray filling from lug boxes on benches adjacent to conveyor belt.....	3	2,266.2	.395	43.8
Method 3. Partial tray filling from bins alongside conveyor belt.....	7	3,291.4	.252	27.5

See footnotes at end of table.

TABLE 17.—Comparative efficiency and cost of direct labor for prepackaging tomatoes, in 14 prepackaging plants in 10 eastern and midwestern cities, according to methods and practices used in performing specified operations, based on 1 week of observation in each plant, February-June 1950—Continued

Operation and method of performance	Number of plants using specified method	Tomatoes prepackaged during week of observation	Man-hours of labor per 100 trays prepackaged	Labor cost per 100 trays prepackaged
Tray-filling and associated operations:--Continued				
8. Setting up and filling trays--Continued				
Method 4. Complete tray filling from bins along-side conveyor belt.....	2	1,288.8	0.337	36.7
Method 5. Complete tray filling and weighing from bins alongside conveyor belt.....	1	477.3	.680	68.0
Total or average.....	2 14	7,533.2	.347	37.5
9. Operating overwrapping machines:				
Faster, more costly machine.....	6	4,851.4	.019	2.1
Slower, less costly machine.....	7	2,472.3	.029	2.9
No overwrapping machine used.....	2	209.5	--	--
Total or average.....	2 14	7,533.2	.022	2.4
10. Setting up, filling, and closing master shipping containers:				
One-piece self-locking box holding 10 trays--manually set up, filled, and closed.....	5	3,422.4	.100	10.0
Two-piece telescope box holding 10 trays--machine stitched and manually filled and closed.....	2	1,885.7	.123	13.4
Two-piece telescope box holding 10 trays--purchased set-up and manually filled and closed.....	2	330.6	.063	10.1

See footnotes at end of table.

TABLE 17.—Comparative efficiency and cost of direct labor for prepackaging tomatoes, in 14 prepackaging plants in 10 eastern and midwestern cities, according to methods and practices used in performing specified operations, based on 1 week of observation in each plant, February-June 1950—Continued

Operation and method of performance	Number of plants using specified method	Tomatoes prepackaged during week of observation	Man-hours of labor per 100 trays prepackaged	Labor cost per 100 trays prepackaged
Tray-filling and associated operations:--Continued				
10. Setting up, filling, and closing master shipping containers--Continued	5	1,894.5	0.092	8.8
Miscellaneous types of master shipping containers.				
Total or average.....	2 14	7,533.2	.102	10.5
11. Removing full master shipping containers.....	14	7,533.2	.030	3.0
Total or average.....	14	7,533.2	.533	56.4
Other operations.....	14	7,533.2	.053	5.3
Total.....	14	7,533.2	1.020	105.1

1 The man-hour requirements and direct labor costs for performing sorting and all associated operations, except dumping, based on 100 pounds of tomatoes sorted, etc., were multiplied by a factor of 1.849, since, in the 14 plants, an average of 184.9 pounds of tomatoes was sorted, etc., per 100 14-ounce trays of tomatoes prepackaged. The man-hour requirements and direct labor costs for dumping, based on 100 pounds of tomatoes dumped, were multiplied by a factor of 1.771, since, in the 14 plants, an average of 177.1 pounds of tomatoes was dumped per 100 14-ounce trays of tomatoes prepackaged.

2 Number of plants totals more than 14 because some plants used more than one method to perform the same operation.

equipment and materials. Other costs should also be taken into account in choosing one of several methods or practices for performing an operation in a tomato pre-packaging plant.

Possible Savings in Direct Labor Cost

A savings in direct labor cost of more than 2.5 cents for each shipping container holding 10 trays from the average labor costs in the 14 surveyed plants could result if the most efficient methods of performing the various prepackaging operations observed in this survey were adopted. If tomatoes were received in both lug boxes and larger, jumble-packed containers, average labor costs could be reduced from \$1.05 to 79.6 cents for each 100 trays prepackaged in these plants (table 18). Man-hours of direct labor could be reduced from 1.02 to 0.75 for each 100 trays prepackaged if all the most efficient methods observed were combined (fig. 8). The average cost of prepackaging tomatoes could be reduced further to 77.2 cents for each 100 trays if tomatoes were received exclusively in the larger containers, since use of such containers would eliminate all the cost of loosening wrappers and reduce the cost of dumping.

More than one-third of the possible savings in man-hours would be effected by sorting tomatoes from one conveyor belt onto other conveyor belts, as this procedure would reduce man-hour requirements for performing this operation by 0.106 man-hour for each 100 trays prepackaged.

An additional one-third of the possible savings in man-hours would result from the adoption of partial tray filling from bins alongside a conveyor belt, as this action would reduce direct labor requirements by 0.095 man-hour per 100 trays prepackaged. Other savings for each 100 trays prepackaged, would amount to 0.029 man-hour if tomatoes were supplied the packaging line by sorting them into the tray-fillers' bins; 0.015 man-hour if containers of unripe tomatoes were hauled on skids to the ripening rooms; 0.014 man-hour if containers of tomatoes were hauled on skids to the sorting line; 0.008 man-hour if empty containers were stacked on conveyors for movement about the prepackaging plant; 0.003 man-hour if the faster, more costly overwrapping machine were used; and 0.002 man-hour if one-piece self-locking master shipping containers were used.

These savings are based on the assumption that tomatoes would be received both in lug boxes and in larger, jumble-packed containers. If tomatoes were received exclusively in the larger containers, in which tomatoes are packed without individual paper wrappers, the entire stripping operation would be eliminated, and thus an additional savings of 0.020 man-hour for each 100 trays prepackaged would result. Also, since tomatoes can be dumped more efficiently from the larger containers, an additional savings of 0.002 man-hour for each 100 trays prepackaged would be effected.

Since the efficiencies of performing prepackaging operations in any one plant are not necessarily the same as those presented as average efficiencies in this report, the savings in man-hours in any one plant could be greater or smaller than indicated.

These savings would be in direct labor only, and would not take into account the increased cost of equipment that might be incurred in order to adopt some of the more efficient methods presented. For instance, the use of a faster, more costly overwrapping machine would result in an average savings of 0.003 man-hour for each 100 trays prepackaged, or about 0.3 percent of total man-hour requirements, although this machine costs about 60 percent more than the slower, less costly machine. In a plant with large volume, this additional equipment cost could be insignificant as compared with the possible savings in direct labor cost and other advantages that might accrue from using the faster, more costly machine. In a plant with small volume, the use of the slower machine may prove more economical. Similarly, sorting from a conveyor belt onto other conveyor belts, although

TABLE 18.—Savings possible in the use of direct labor through the application of the most efficient methods and practices used to perform prepackaging operations, based on 1 week of observation in each of 14 tomato prepackaging plants in 10 eastern and midwestern cities, February-June 1950

Most efficient method of performing operation	Average cost of performing operation--per 100 trays prepackaged		Cost of most efficient method of performing operation--per 100 trays prepackaged		Possible savings --per 100 trays prepackaged
	Man-hours	Cents	Man-hours	Cents	
Sorting and associated operations:					
1. Hauling containers of tomatoes on skids to sorting line.....	0.031	3.0	0.017	1.8	0.014 1.2
2. Dumping tomatoes onto sorting conveyor belt.....	.046	5.1	1 .046	1 5.1	(¹)
3. Stacking empty containers on conveyors.....	.026	2.6	.018	1.8	.008 .8
4. Loosening wrappers from tomatoes.....	.020	2.0	2 .020	2 2.0	(²)
5. Sorting tomatoes from one conveyor belt onto other conveyor belts.....	.263	26.3	.157	17.6	.106 8.7
6. Hauling containers of unripe tomatoes on skids to ripening rooms ³	.048	4.4	.033	3.1	.015 1.3
Total.....	.434	43.4	.292	31.4	.143 12.0
Tray-filling and associated operations:					
7. Sorting tomatoes into tray-fillers' bins.....	.032	3.0	.003	0.3	.029 2.7
8. Partial tray-filling from bins alongside conveyor belt.....	.347	37.5	.252	27.5	.095 10.0
9. Operating faster, more costly overwrapping machine...	.022	2.4	.019	2.1	.003 .3
10. Setting up, filling, and closing one-piece, self-locking master shipping containers.....	.102	10.5	.100	10.0	.002 .5
11. Removing full master shipping containers.....	.030	3.0	.030	3.0	-- --
Total.....	.533	56.4	.404	42.9	.129 13.5
Other operations.....	.053	5.3	.053	5.3	-- --
Total.....	1.020	105.1	.748	79.6	.272 25.5

¹ If tomatoes were received in bulk containers only, the cost of dumping would be reduced to 0.044 man-hour, or 4.9 cents, thus resulting in an additional savings of 0.002 man-hour, or 0.2 cents per 100 trays prepackaged.

² If tomatoes were received in bulk containers only, the cost of loosening wrappers would be completely eliminated, thus resulting in an additional savings of 0.020 man-hour, or 2.2 cents.

³ Although this method was the second most efficient method of removing containers of unripe tomatoes to ripening rooms as presented in table 17, it was the most efficient, as presented in table 12, in which the distance the tomatoes were moved was also taken into account.

MAN-HOURS OF DIRECT LABOR PER 100 TRAYS PREPACKAGED, BY SPECIFIED OPERATIONS

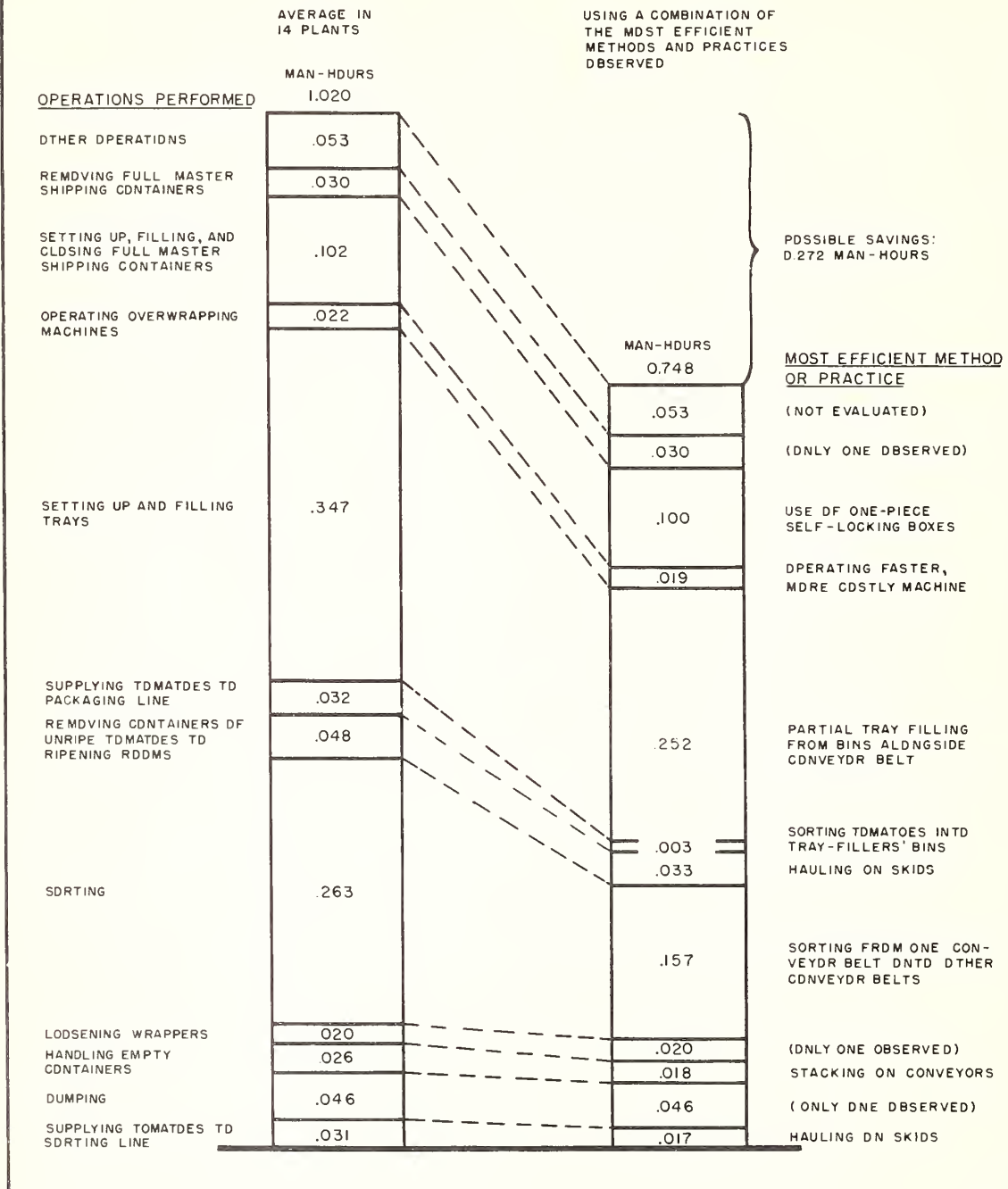


Figure 8.—Comparison of efficiency, by specified operations, of direct labor used in 14 tomato pre-packaging plants with possible direct labor efficiency using a combination of the most efficient methods and practices observed in these plants.

the most efficient method evaluated, requires the use of conveyors that are fairly expensive as compared with the equipment required to sort from belts into bins, the next most efficient method. Therefore, in deciding whether or not to adopt a more efficient method, possible savings in labor cost must be weighed against possible increases in other costs.

Furthermore, it should be remembered that the effects on the quality of the tomatoes of the various methods and practices studied for performing the prepackaging operations were not measured. What were found to be the more efficient methods and practices possibly may result in greater waste and spoilage of tomatoes in the plants or in the packages than the less efficient methods and practices. Care should be taken to eliminate those features of any methods or practices resulting in rough handling of the tomatoes.

Suggested Layouts for Tomato Prepackaging Plants⁴

Small prepackaging plant. --Various methods and practices of prepackaging tomatoes have been described and evaluated herein as used in 14 selected terminal market tomato prepackaging plants surveyed between February and June 1950, in 10 eastern and mid-western cities. On the basis of these observations and evaluations, diagrams of two model layouts are now presented. Figure 9 shows a suggested layout for a small tomato prepackaging plant prepackaging weekly up to 50,000 pounds, or about 6,000 master shipping containers of tomatoes, of 10 trays each.

(1) New receipts of mature green tomatoes are brought up either on skids from a holding area or on a portable gravity conveyor from a truck or railroad car to the dumping table of the sorting conveyor belt. If these shipping containers are not lug boxes to be re-used in the plant, they are immediately removed from the dumping table and the working floor, after they are emptied, by means of either skids or another portable gravity conveyor. Once dumped, the tomatoes pass under a blower and a spray-type of washer, if this equipment is to be used. (Although provision is made for the installation of a washer over the sorting conveyor belt, the actual installation of this equipment is not specifically recommended. Some operators suggested, however, that a washer be used in order to help remove any dirt or decayed material accumulated during shipment or ripening.)

(2) If the containers from which the tomatoes were dumped are lug boxes to be re-used inside the plant, they are placed on an over-head gravity conveyor. This conveyor carries them over the length of the sorting conveyor belt for convenient removal by the sorting operators. The gravity conveyor for empty lugs might be installed under, rather than over, the sorting conveyor belt. The sorting operators, standing along one side of this belt, sort the tomatoes as they pass down the belt both for culls and for stage of ripeness. In order that the tomatoes be properly sorted, it is suggested that adequate lighting equipment be installed over all important working areas. The light provided should be constant both in intensity and hue. Many of the plants surveyed provided adequate lighting by installing fluorescent lighting fixtures directly over the sorting and tray-filling conveyor belts.

(3) Tomatoes ripe enough to be packaged are sorted directly into bins for packageable tomatoes on the side of the sorting conveyor belt opposite the sorting stations.

(4) The unsalable culls are sorted into cans behind the sorting operators, and those tomatoes that are salable only at marked-down prices are sorted into appropriate lug boxes set astride the sorting conveyor belt or on benches beside the sorting conveyor belt.

(5) If repacking of tomatoes into lug boxes or other containers is to be performed in the plant, ripe tomatoes that are to be repacked are also sorted into appropriate lug boxes. When filled, these lug boxes are placed on skids and removed to a convenient repacking area.

⁴ Caleb J. Otten and Paul F. Shaffer, agricultural marketing specialists of the staff of the Marketing and Facilities Research Branch, Production and Marketing Administration, assisted in the development of the plant layouts suggested.

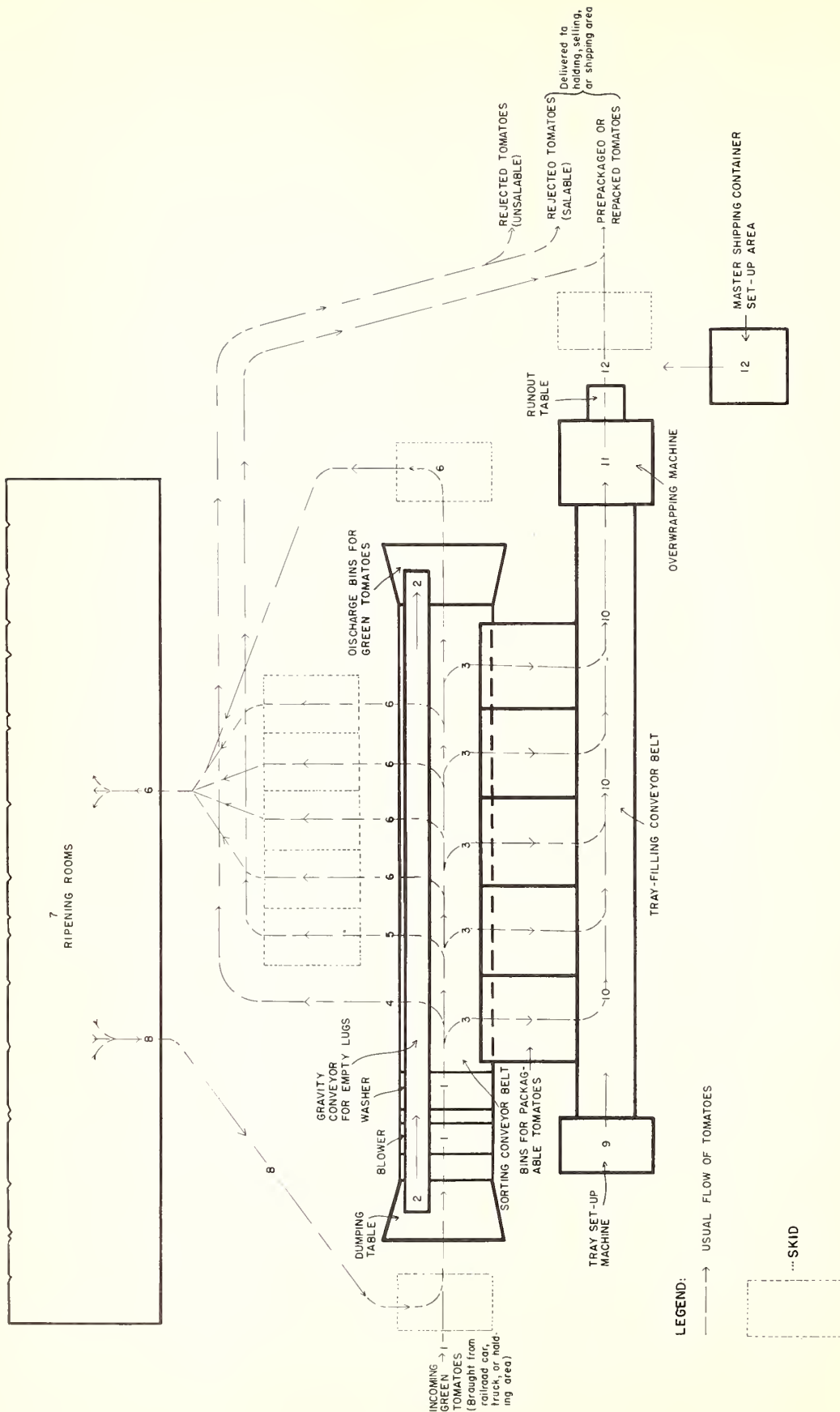


Figure 9.—Layout for small tomato prepackaging plant.
(See text for description of numbered parts of diagram)

(6) Tomatoes at an advanced stage of ripeness, but not ripe enough for packaging, are sorted into appropriate lug boxes set astride, or on benches beside, the sorting conveyor belt. When these lug boxes are full, the sorting operators place them on nearby skids for removal to the nearest appropriate ripening room. The mature green tomatoes collected in discharge bins at the end of the sorting conveyor belt are emptied into lug boxes, placed on skids, and removed to the nearest appropriate ripening room, as are the tomatoes of intermediate ripeness.

(7) It is suggested, however, that ripening-room capacity in small-size plants be equal to at least twice the contemplated maximum weekly production of prepackaged and repacked tomatoes in order to meet peak inventory requirements. It is also suggested that proper air circulation and effective temperature and humidity controls be provided for these rooms and that provision be made for keeping the ripening rooms clean. Since these rooms should be regularly washed, water outlets, floor drains, and proper floor slope should be considered in their design.

(8) When the skid loads of tomatoes taken to the ripening rooms have ripened, they are returned to the sorting line for resorting.

Adjacent to the bins for packageable tomatoes is a tray-filling conveyor belt.

(9) A tray set-up machine, either on the main working floor or on the mezzanine floor above the main working floor, mechanically sets up trays and automatically feeds a stream of set-up trays onto the tray-filling conveyor belt. If the tray set-up machine is on a level above the main working floor, set-up trays are automatically delivered to the tray-filling conveyor belt by means of a chute.

(10) As the trays pass down the tray-filling conveyor belt, they are filled (by tray-filling operators stationed along one side of this belt) with tomatoes from the bins adjoining the other side of this belt. The trays are filled by the partial tray-filling method, that is, any one operator places only one or two tomatoes into any one tray. The tray-filling operator nearest the tray set-up machine, in addition to filling trays with tomatoes, supplies the machine with knocked-down trays and examines the set-up trays as they emerge for improper operation of the machine. If the machine is on a level above the main working floor, a special operator is needed for it.

(11) After the trays are filled, they continue down the tray-filling conveyor belt and automatically pass into the overwrapping machine. This machine overwraps each full tray in a sheet of transparent film. The trays then emerge from the overwrapping machine onto the runout table, where an operator places them into fiber-board master shipping containers. These containers are then placed on skids for shipment out of the plant.

(12) Master shipping containers are set up either on the main working floor near the runout table or on the mezzanine or floor above the main working floor. If they are set up on a level above the main working floor, they can be delivered through a chute or hopper to the box-filling station on the main working floor. Receipts of knocked-down shipping containers can be delivered directly to the upper level by means of a portable power conveyor leading from outside the plant, through an outside door at the upper level, to a storage area near the box set-up area. This practice will keep most bulky paper supplies off the more valuable working floor space below.

In order to prevent the return of dust- and fungus-laden air removed by the blowers, it is suggested that the cage should be placed so that this air will be exhausted outside of the plant.

It was noted during this survey that regular cleaning of all equipment was practiced in most of the plants visited. This was done not only for sanitary reasons, but also

to keep the machinery functioning properly. It is therefore suggested that all equipment installed in the tomato prepackaging plant be easily accessible for cleaning.

Large prepackaging plant.--Figure 10 shows a suggested layout for a large plant prepackaging weekly about 100,000 pounds, or 12,000 boxes of tomatoes of 10 trays each. (1) New receipts of mature green tomatoes are brought up either on portable gravity conveyors from a truck or a railroad car, or on skids from a holding area, to the dumping table of sorting conveyor belt (A). Containers not to be re-used inside the plant, after they are emptied, are immediately removed from the dumping table and working floor by means of other portable gravity conveyors or skids. It is suggested as a usual, although not rigid, operating procedure that tomatoes of sizes suitable for placing into trays holding four tomatoes each be dumped and sorted on one side of sorting conveyor belt (A), and that those to go into packages of three or five tomatoes each be dumped and sorted on the other side of sorting conveyor belt (A). This separation of the three sizes between the two halves of the plant, which are identical, should be maintained throughout the entire prepackaging operation. An excess demand for 4's could, of course, be handled on the side of the 3's and 5's whenever necessary, and vice versa. Once dumped, the tomatoes pass under a blower and a spray-type washer, if this equipment is to be used.

(Although provision is made for the installation of washers over the sorting conveyor belts, the actual installation of this equipment is not specifically recommended. Some operators suggested, however, that washers be used in order to help remove any dirt or decayed material accumulated during shipment or during ripening.)

(2) If the containers from which the tomatoes are being dumped are lug boxes to be re-used inside the plant, they are placed on an overhead gravity conveyor. This conveyor carries them over the length of sorting conveyor belt (A) for convenient removal by the sorting operators. Sometimes lug boxes required by the sorting operators will not be forthcoming from the dumping station because tomatoes are being dumped from another type of container. In this case the overhead gravity conveyor for empty lugs is itself supplied empty lug boxes by means of another gravity conveyor connecting its discharge end with a lug-box storage area on the mezzanine or floor above. After the tomatoes pass under the blower and washer, they continue down sorting conveyor belt (A) on past the sorting operators, who are stationed on either or both sides of this belt, this depending on the sizes of the tomatoes being sorted.

In order that the tomatoes be properly sorted, it is suggested that adequate lighting equipment be installed over all important working areas. The light provided should be constant both in intensity and hue. Many of the plants surveyed provided adequate lighting by installing fluorescent lighting fixtures directly over the sorting and tray-filling conveyor belts.

Since this is the first time that these new receipts of tomatoes are being sorted in the plant, most of the tomatoes usually are mature green, turns, pinks, and ripe ranking second, third, and fourth in order of occurrence.

(3) Tomatoes in the second most prevalent stage of ripeness, usually turns, are sorted onto the lower of two narrow conveyor belts tiered between the center of sorting conveyor belt (A) and the overhead gravity conveyor for empty lugs. Tomatoes in the third most prevalent stage of ripeness, usually pinks, are sorted onto the higher of these two narrow conveyor belts.

(4) The unsalable culls are sorted into cans behind the sorting operators, and culls that are salable at marked-down prices are sorted into appropriate lug boxes set on benches beside the sorting conveyor belt.

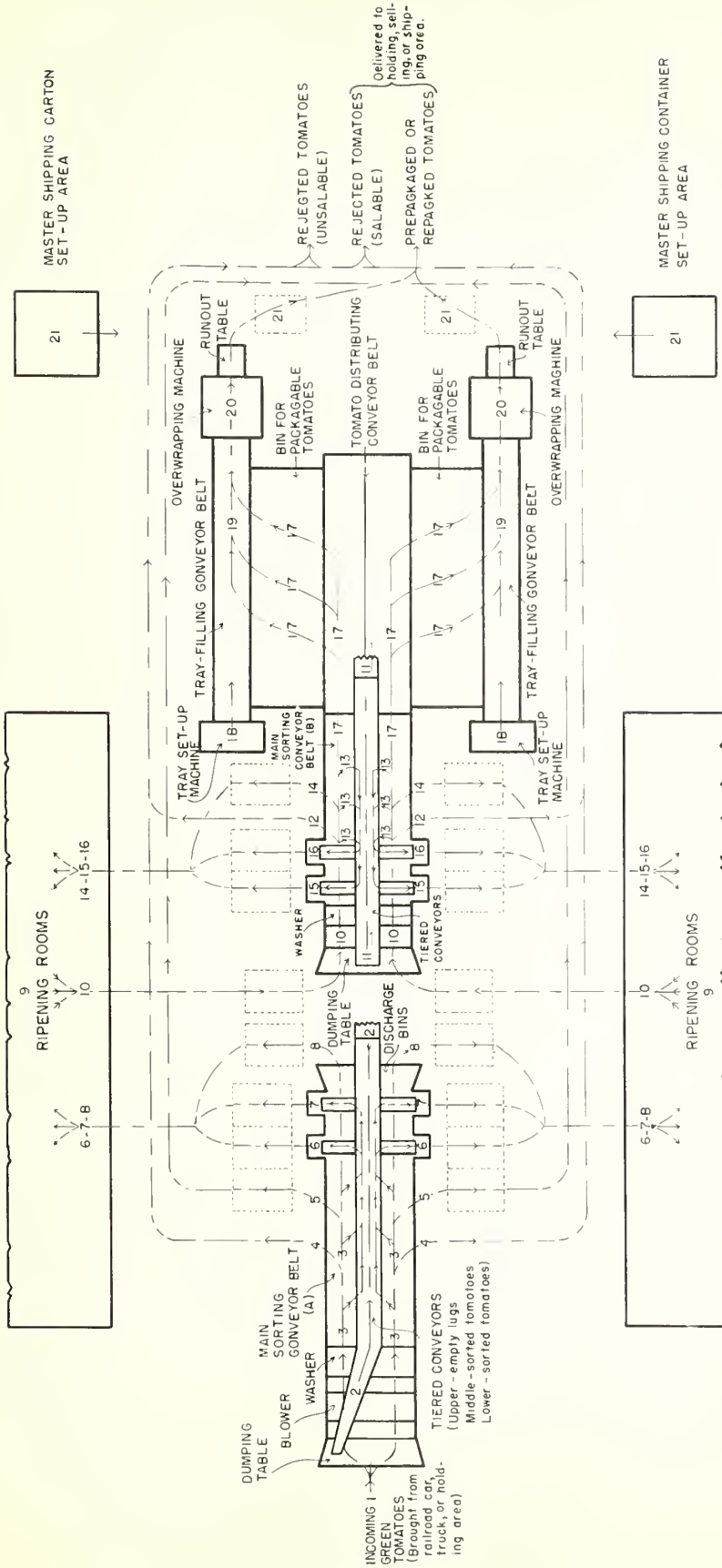


Figure 10. —Layout for large tomato prepackaging plant.
(See text for description of numbered parts of diagram)

(5) Tomatoes in the least prevalent stage of ripeness, usually ripens, are taken off into lug boxes set on benches beside the sorting conveyor belt. They are then placed on skids and removed to the packaging line if the tomatoes are to be packaged, or to a repacking area if they are to be repacked into lug boxes or other containers.

(6) Those tomatoes in a turn stage of ripeness are collected into lug boxes placed on a bench under a trough discharging from the lower of the two narrow conveyor belts. The turns are then placed on skids and removed to a ripening room for further ripening.

(7) The pink tomatoes are collected into lug boxes placed on a bench under a trough discharging from the higher of the two narrow conveyor belts. The pinks are then placed on skids and removed to a ripening room for further ripening.

(8) Mature green tomatoes are usually most prevalent at this initial sorting and are allowed to pass down the full length of the sorting conveyor belt (A) and into the discharge bins. They are then emptied into lug boxes, placed on skids and removed to a ripening room for further ripening.

The sorting of the tomatoes into lots of similar stages of ripeness need not rigidly follow the method outlined previously in 3, 5, 6, 7, and 8. If the most prevalent stage of ripeness is one other than mature green, these tomatoes might be allowed to pass down the full length of sorting conveyor belt (A), and the less prevalent kinds, including the mature greens, might more conveniently be sorted onto the tiered narrow conveyor belts or into lug boxes.

(9) It is suggested that ripening-room capacity in large plants, that is, in those in which it is expected that as much as 100,000 pounds of tomatoes will be prepackaged or repacked weekly, be equal to at least twice the contemplated maximum weekly production of prepackaged and repacked tomatoes. It is also suggested that proper air circulation and effective temperature and humidity controls be provided for these rooms, and that provision be made for keeping the ripening rooms clean. Since these rooms should be regularly washed, water outlets, floor drains, and proper floor slope should be considered in their design.

(10) When the skid loads of tomatoes taken to the ripening rooms have ripened, they are removed from the ripening rooms and taken to the dumping table of sorting conveyor belt (B). Once dumped onto sorting conveyor belt (B), the tomatoes pass under a spray-type washer, if this equipment is to be used.

(11) Most of the tomatoes dumped onto sorting conveyor belt (B) probably are ripe enough to be prepackaged or repacked, and only a small portion of the lug boxes emptied by the dumping operator are required for use by the sorting operators. Most of the lug boxes emptied and placed on the overhead gravity conveyor are therefore sent down the entire length of this gravity conveyor, and are removed by means of a connecting power conveyor belt to the mezzanine floor above. This power conveyor belt connects on the mezzanine with the gravity conveyor that supplies lug boxes to the sorting operators stationed alongside sorting conveyor belt (A). Sometimes the dumping operator at sorting conveyor belt (B) will place more lug boxes on the lug-box-supplying conveyor system than are required by the sorting operators at sorting conveyor belt (A). The empty lug boxes then pass over the full length of the overhead gravity conveyor and onto the power conveyor, which carries them to the gravity conveyor on the upper level. The lug boxes are then toppled from this gravity conveyor, by means of an upset device, for storage on the upper level. Otherwise, the empty lug boxes continue along this conveyor system back to the main working floor and sorting conveyor belt (A), where they are used for collecting sorted tomatoes. On the other hand, if more lug boxes are required at sorting conveyor belt (A) than are forthcoming from sorting conveyor belt (B), lug boxes previously toppled from the gravity conveyor on the upper level can be placed back

on that gravity conveyor, which takes them to sorting conveyor belt (A). This is the only special labor required for the handling of lug boxes and probably can be performed, when required, by operators already stationed on the upper level.

After the tomatoes emerge from under the washer, they continue down sorting conveyor belt (B) and past the sorting operators, who are stationed on either or both sides of this belt, their position depending on the sizes of the tomatoes being dumped. Since the tomatoes dumped onto sorting conveyor belt (B) have been ripened in the ripening rooms, most of them usually will be ripe, the pinks, turns, and mature greens ranking second, third, and fourth in order of occurrence.

(12) The unsalable culls are sorted into cans behind the sorting operators, and those tomatoes that are salable only at marked-down prices are sorted into appropriate lug boxes set on benches beside the sorting conveyor belt.

(13) Tomatoes in the second most prevalent stage of ripeness, usually pinks, are sorted onto the lower of two narrow conveyor belts tiered between the center of sorting conveyor belt (B) and the overhead gravity conveyor for empty lugs. Tomatoes in the third most prevalent stage of ripeness, usually turns, are sorted onto the higher of these two tiered belts.

(14) Tomatoes in the least prevalent stage of ripeness, usually mature greens, are taken off into lug boxes set on benches beside the sorting operators.

(15) Tomatoes in a turn stage of ripeness are collected into lug boxes placed on a bench under a trough discharging from the higher of the two narrow conveyor belts. They are then placed on skids and removed to a ripening room for further ripening.

(16) The pink tomatoes are collected into lug boxes placed on a bench under a trough discharging from the lower of the two narrow conveyor belts. They are then placed on skids and removed to a ripening room for further ripening.

(17) Tomatoes in stages of ripeness suitable for immediate packaging, which are usually most prevalent at this sorting, are always allowed to pass down the full length of sorting conveyor belt (B), from which they are discharged onto the tomato distributing conveyor belt. They are then evenly distributed, either by means of a gravity or mechanical arrangement, into the bins for packageable tomatoes on either side of the last-mentioned conveyor belt. One observed method of distributing the tomatoes into the bins made use of a wedgelike "plow" that moved slowly up and down the length of the tomato-distributing conveyor belt, pushing the ripe tomatoes off the conveyor belt into the bins for packageable tomatoes. Since some prepackaging plant operators object to the use of a plow, claiming that it bruises the tomatoes, an alternate procedure, not observed in the plants surveyed, might be to tilt each side of the tomato-distributing conveyor belt toward the bins for packageable tomatoes. Each half of this belt would be tilted at a progressively sharper angle from the beginning to the end of the bins, so that the tomatoes, as they proceeded toward the end of the packaging line, would be increasingly likely to roll into the bins. Those tomatoes that reached the end of the packaging line would be pushed into the bins by a stationary wedgelike "plow" at the end of the belt.

Adjacent to each of the two bins for packageable tomatoes, which are supplied tomatoes by the tomato-distributing conveyor belt, is a tray-filling conveyor belt.

(18) Tray set-up machines, either on the main working floor or on the mezzanine or floor above the main working floor, mechanically set up trays and automatically feed them onto each tray-filling conveyor belt. If the tray set-up machines are on a level above the main working floor, set-up trays are automatically delivered to the tray-filling conveyor belts by means of chutes.

(19) As the trays pass along each of the two tray-filling conveyor belts, they are filled (by tray-filling operators stationed along one side of each of these conveyor belts) with tomatoes from the bins adjoining the other side of each of these conveyor belts. The trays are filled by the partial tray-filling method, that is, any one operator places only one or two tomatoes into any one tray. The tray-filling operator nearest each of the two tray set-up machines, in addition to filling trays with tomatoes, supplies the machine with knocked-down trays and examines the set-up trays for imperfections. If the machines are on a level above the main working floor, special operators are needed.

(20) After the trays are filled, they continue along each of the tray-filling conveyor belts and automatically pass into the overwrapping machines at the ends of these belts. These machines overwrap each full tray in a sheet of transparent film. The trays then emerge from each overwrapping machine onto a runout table, where an operator places them into fiberboard master shipping containers. These containers are placed on skids for shipment out of the plant.

(21) Master shipping containers are set up either on the main working floor near each runout table or on the mezzanine or floor above the main working floor. If they are set up on a level above the main working floor, they can be delivered through chutes or hoppers to the box-filling stations on the main working floor. Receipts of knocked-down shipping containers can be delivered directly to the upper level by means of a portable power conveyor leading from outside the plant, through an outside door at the upper level, to a box storage area near the box set-up areas. This practice will keep most bulky paper supplies off the more valuable working floor space below.

The use of two sorting conveyor belts in a large plant is based on the assumption that the majority of tomatoes arriving in original containers will be in need of further ripening, as they were in the plants surveyed. Should the majority of tomatoes arriving in original containers be ripe enough for packaging, original containers of tomatoes could first be sorted on sorting conveyor belt (B) instead of sorting conveyor belt (A), and the need for sorting conveyor belt (A) thus eliminated.

An alternative to the method of sorting recommended for the plant under consideration (using the method of sorting from one conveyor belt onto other conveyor belts), would involve sorting the tomatoes among a number of lengthwise partitions on the same conveyor belt. Dividers, about the height of a tomato, could be set up lengthwise, a fraction of an inch above the surface of the conveyor belt, and the tomatoes sorted among these dividers. If most of the tomatoes were ripe enough for packaging, they could be run off onto a tomato-distributing conveyor like that shown in figure 10. Tomatoes needing further ripening could be taken off into lug boxes from troughs at various places near the discharge end of the sorting conveyor belt. The principle involved in this method would be the same as sorting from one conveyor belt onto other conveyor belts, but the work of lifting the tomatoes from the main conveyor belt to the two tiered belts would be eliminated, since, by using this alternative method, the sorting operators would lift the tomatoes only as high as the dividers.

In order to prevent the return of dust- and fungus-laden air removed by the blowers, it is suggested that the cage should be placed so that this air will be exhausted outside of the plant.

It was noted during this survey that regular cleaning of all equipment was practiced in most of the plants visited. This was done not only for sanitary reasons, but also to keep the machinery functioning properly. It is therefore suggested that all equipment installed in the tomato prepackaging plant be easily accessible for cleaning.

EVALUATION OF PREPACKAGED TOMATOES PURCHASED IN RETAIL STORES

Types and Frequencies of Defects

As outlined in the introduction of this report, a total of 423 packages of tomatoes were purchased by research workers in 141 retail food stores in 10 eastern and midwestern cities, in order to ascertain the average quality and condition of tomatoes in consumer packages on display in retail food stores. These packages of tomatoes were randomly selected from each store's display. Sixty percent of the tomatoes purchased were packaged in the tomato prepackaging plants surveyed, and 40 percent were packaged in plants not surveyed. Each of the packages of tomatoes purchased was weighed. The stage of ripeness and size of each tomato were determined and systematically recorded, and each type of defect found on each tomato was recorded.

A total of 1,673 tomatoes was purchased and examined. Of these, 1,461, or 87 percent, were found in a salable condition, and 360 of these tomatoes, or 22 percent of all tomatoes purchased, were found without defects of any kind⁵ and therefore were judged "perfect" (table 19). Seventy-eight percent or 1,313 of all the tomatoes purchased had one or more defects of one sort or another. These tomatoes were judged "imperfect." Of these tomatoes, a total of 212, constituting 13 percent of all the tomatoes purchased, was in an unsalable condition because they were moldy, rotten, or immature.

The most important single defect found was pressure bruising. A total of 37 percent of all of the prepackaged tomatoes purchased was found to be pressure bruised, with varying degrees of severity. Other important defects were scars, which were found in varying degrees of severity among 30 percent of the tomatoes purchased; puffiness, found among 25 percent; and shriveled skin, found among 20 percent.

The individual defects discovered among the prepackaged tomatoes purchased were grouped into four distinct categories: Abnormal coloring, puffiness or excessive softness, blemishes or defects probably occurring before harvest, and blemishes or decay probably occurring after harvest. Any tomato may have had, and many did have, more than one defect. Therefore, any tomato could have fallen into more than one defect category. Because of this, there is a certain amount of overlapping of quantitative data among the defect categories discussed in this report. The types of defects listed in table 19 are defined as follows:

Definitions of defects

Type of defect	Definition
Abnormal coloring: Uneven coloring	Green or yellow areas on surface of otherwise ripe tomatoes. Usually associated with certain diseases, sunburn, chilling injury, improper ripening conditions, and some causes unknown.
Immature tomato	Picked too early to ripen properly.

⁵ The incidence of specified individual defects, rather than U. S. standard grades, was used as a measure of the quality and condition of the tomatoes because the former was thought to be a more sensitive measure for the purposes of this study, and because it made possible analyses by types of defects.

Definitions of defects--Continued

Type of defect	Definition
Puffiness or excessive softness:	
Puffy	Tomatoes which are usually angular or flat sided with one or more locules showing open space.
Too soft	Entire tomato too soft to be sliced for table use. Usually associated with over-ripeness, bruising, high temperature during ripening, and, occasionally, to a condition known as thin wall.
Soft spots	Bruised areas on the tomato that become soft as the tomato ripens. Not readily apparent from visual inspection only.
Blemishes or defects probably occurring before harvest:	
Scars	Discolored or scarred areas on surface of tomato. These areas may or may not be rough or leathery (shoulder scars, particularly, may occur after harvest).
Black scars around stem end	Black, sunken scars adjacent to stem scar.
Growth cracks	Ruptures or cracks radiating from, or concentric to, stem scar.
Excessive core	Hard, fibrous tissue in core, extending well into tomato.
Catface	Malformation and scarring at blossom end of tomato.
Blemishes or decay probably occurring after harvest:	
Pressure bruise	Damage to the fruit tissues caused by pressure without breaking the skin. When severely damaged, tissues appear water-soaked.
Shriveled skin	A wrinkling of the skin due to loss of moisture frequently caused by inadequate relative humidity in ripening rooms. Worse if tomatoes are immature. Also caused by sun scald or by slight freezing injury in the field, or by contact with soil resulting in stained area on fruit.
Feathering	A slight mechanical injury causing the injured skin to curl back. Worse on immature fruits.
Rot	Any decomposition of the fruit tissues due to any organism.

Definitions of defects--Continued

Type of defect	Definition
Blemishes or decay probably occurring after harvest--Con.:	
Mechanical skin break	Skin broken by mechanical means, such as cuts and punctures. Much more serious than feathering.
Moldy	Mold at skin breaks, but not an active rot.

No attempt was made in this survey to measure the severity of these defects.

Of all the prepackaged tomatoes purchased, 183, or about 11 percent, had abnormal coloring. Most of these tomatoes were unevenly colored, and some were picked prematurely and would never have ripened sufficiently to be acceptable for table use. These immature tomatoes were also judged to be in an unsalable condition.

A total of 504, or 30 percent of all the prepackaged tomatoes purchased, had defects falling into the puffiness or excessive softness category. Generally, an advanced stage of ripeness and the presence of bruising were associated with excessive softness among the tomatoes purchased.

Five hundred sixty-seven, or about 34 percent of all the prepackaged tomatoes purchased had blemishes or defects that probably occurred before the tomatoes were harvested. Scars accounted for the majority of defects found in this category.

Of all the prepackaged tomatoes purchased, 948, or about 57 percent, had blemishes or decay that probably occurred after the tomatoes were harvested. These defects probably were not evident at shipping point, but could have become evident anywhere in the marketing system beyond the shipping point. Tomatoes showing rot or mold were considered in an unsalable condition.

Stage of Ripeness and Size of Tomatoes Purchased⁶

Fifty-six percent of all the prepackaged tomatoes purchased in retail stores were firm ripe, and 22 percent were hard ripe. Seventeen percent were soft ripe, a stage of ripeness usually considered less desirable for table use. Approximately 5 percent of all the tomatoes purchased were pinks or turns and would have had to be further ripened by the purchaser for table use.

The average net weight per package of all 423 packages of tomatoes purchased was 14.1 ounces (table 20). Packages containing 3 tomatoes averaged 14.3 ounces, and those containing 4 tomatoes averaged 14.2 ounces. Packages of 5 tomatoes were about an ounce lighter in weight, averaging 13.3 ounces. Tomatoes in 3-unit packages had an average minimum diameter of 2.6 inches, and tomatoes in 4- and 5-unit packages averaged 2.4 inches and 2.2 inches, respectively.

Packages containing five tomatoes provided more value in terms of price per pound than did packages containing three or four tomatoes. Packages of five tomatoes cost an average of 21.0 cents a pound, as compared with packages of four tomatoes, which averaged 25.8 cents a pound, and packages of three tomatoes, which averaged 27.6 cents a pound.

Factors Associated with Types and Frequencies of Defects

It was not feasible to determine the specific causes of the various individual defects found among the tomatoes purchased, although the relationships between the

⁶ For an explanation of the various stages of tomato maturity (ripeness), see U.S. Consumer Standards for Fresh Tomatoes, effective October 10, 1948., USDA.

TABLE 19.—Types and frequencies of specified defects of 1,673 tomatoes in 423 packages purchased from 141 retail food stores in 10 eastern and midwestern cities, February-June 1950

Type of defect	Number of tomatoes	Percentage of all tomatoes purchased
	<i>Number</i>	<i>Percent</i>
Abnormal coloring:		
Uneven coloring.....	172	10.3
Immature.....	17	1.0
Total ¹	183	10.9
Puffiness or excessive softness:		
Puffy.....	423	25.3
Too soft.....	97	5.8
Soft spots.....	19	1.1
Total ¹	504	30.1
Blemishes or defects probably occurring before harvest:		
Scarred.....	504	30.1
Black scars around stem end.....	59	3.5
Growth cracks.....	23	1.4
Excessive core.....	2	.1
Catface.....	2	.1
Total ¹	567	33.9
Blemishes or decay probably occurring after harvest:		
Pressure-bruised.....	621	37.1
Shriveled skin.....	339	20.3
Feathering.....	245	14.6
Rot.....	157	9.4
Mechanical skin break.....	95	5.7
Moldy.....	63	3.8
Total ¹	948	56.7
Total imperfect tomatoes ¹	1,313	78.5
Total perfect tomatoes.....	360	21.5
Total tomatoes purchased.....	1,673	100.0
Total tomatoes in salable condition.....	1,461	87.3
Total tomatoes in unsalable condition ²	212	12.7
Total tomatoes purchased.....	1,673	100.0

¹ Since many tomatoes may have had more than one defect, totals do not represent additions of the figures given.

² Moldy, rotten, or immature tomatoes.

TABLE 20.—Average weight, price, and size of prepackaged tomatoes, according to number of tomatoes in consumer packages, based on observations of 1,673 tomatoes in 423 packages purchased from 141 retail food stores in 10 eastern and midwestern cities, February-June 1950

Tomatoes per package	Packages purchased	Average minimum diameter of each tomato ¹	Average weight per package	Average retail price per pound
	<i>Number</i>	<i>Inches</i>	<i>Ounces</i>	<i>Cents</i>
Three.....	68	2.6	14.3	27.6
Four.....	306	2.4	14.2	25.8
Five.....	49	2.2	13.3	21.0
Total or average..	423	2.4	14.1	25.6

¹ "The measurement for minimum diameter shall be the largest diameter of the tomato taken at right angles to a line from the stem end to the blossom end," U.S. Standards for Fresh Tomatoes, USDA, 1949.

types and frequencies of defects and a number of factors, such as the size and ripeness of the tomatoes, were investigated.

Size of tomatoes.--Tomatoes in an unsalable condition ranged from 10 to 22 percent of all tomatoes purchased in each size group (table 21). A greater proportion of the smallest and largest tomatoes was found in an unsalable condition than was of the medium sized tomatoes.

Stage of ripeness of tomatoes.--There was some relationship, as would be expected, between the types and frequencies of defects and the stage of ripeness of the tomatoes. A total of 26 percent of the soft ripe tomatoes was found in an unsalable condition, as compared with a total of 7 to 13 percent of the tomatoes in other stages of ripeness (table 22). Generally, a greater proportion of the less ripe tomatoes was abnormally colored. Puffiness, or excessive softness, was found most frequently among the soft ripe tomatoes, and riper tomatoes had more blemishes or decay than did less ripe tomatoes. A total of 88 percent of the soft ripe tomatoes was imperfect, as compared with a range of 76 to 80 percent of the tomatoes in other stages of ripeness that were found imperfect.

Other factors.--The relationships between types and frequencies of defects and a number of other factors were investigated and found not statistically significant at the 5 percent level. For example, no significant association was found between the amount of visibility provided by various types of consumer packages and the types and frequencies of defects among the tomatoes packaged in them. Three types of consumer packages of tomatoes were purchased. In two of these, window cartons and trays with end flaps, tomatoes placed in the corners or end positions of the packages were partly concealed. Trays without end flaps, the third type of package purchased, provided the most visibility for all the tomatoes in the package. A total of 6 percent of the tomatoes purchased in trays without end flaps was in an unsalable condition, as compared with 13 percent in each of the other two types of packages. A total of 22 percent of the tomatoes purchased in either window cartons or trays with end flaps was found "perfect" as compared with 16 percent in trays without end flaps. However, both of the above comparisons of percentages are not statistically significant at the 5 percent level. Among both window cartons and trays with end flaps there was little difference between the quality and condition of tomatoes placed in the corners of these packages and of those placed in the middle, more visible positions.

Another factor investigated and not found significantly related to the types and frequencies of defects was the type of shipping container in which the tomatoes were received in the prepackaging plant. Ten percent of the tomatoes prepackaged in plants

TABLE 21.—Occurrence of specified type of defect, according to minimum diameters of tomatoes, based on observations of 1,673 prepackaged tomatoes in 423 packages purchased from 141 retail food stores in 10 eastern and midwestern cities, February-June 1950

Minimum diameter (inches)	Tomatoes purchased	Percentage imperfect tomatoes by type of defect						Total percentage perfect tomatoes
		Abnormal color	Puffiness or excessive softness	Blemishes or defects prob- ably occur- ring before harvest	Blemishes or decay prob- ably occur- ring after harvest	Total percent- age in unsalable condi- tion ¹	Total percent- age im- perfect tomatoes ²	
Less than 2-1/16.....	Number 46	Percent 2.7	Percent 4.3	Percent 26.1	Percent 34.8	Percent 69.6	Percent 21.7	Percent 21.7
2-1/16 to 2-1/4.....	356	21.3	9.0	31.5	21.9	55.6	11.0	24.4
2-5/16 to 2-1/2.....	763	45.7	11.1	29.2	33.8	54.8	11.8	22.4
2-9/16 to 2-3/4.....	417	24.9	12.9	29.7	40.8	57.1	10.3	18.7
Over 2-3/4.....	74	4.4	13.5	32.4	54.1	60.8	17.6	17.6
Unknown ³	17	1.0	0.0	52.9	29.4	94.1	100.0	5.9
Total.....	1,673	100.0	10.9	30.1	33.9	56.7	12.7	21.5

¹ Moldy, rotten, or immature tomatoes only.

² Since many tomatoes may have had more than one type of defect, the total percentage imperfect tomatoes does not represent an addition of percentages under types of defects.

³ Tomatoes had decomposed to a point where accurate measurements of their minimum diameters were impossible.

TABLE 22. — Occurrence of specified type of defect, according to stage of ripeness, based on observations of 1,673 prepackaged tomatoes purchased from 141 retail food stores in 10 eastern and midwestern cities, February-June 1950

Stage of ripeness	Tomatoes purchased		Percentage imperfect tomatoes by type of defect						Total percentage perfect tomatoes
			Abnormal color	Puffiness or excessive softness	Blemishes or defects probably occurring before harvest	Blemishes or decay probably occurring after harvest	Total percentage in unsalable condition ¹	Total percentage imperfect tomatoes ²	
Turn and pink.... Hard ripe..... Firm ripe..... Soft ripe..... Total.....	Number	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
	86	5.1	55.8	24.4	22.1	32.6	12.8	80.2	19.8
	364	21.8	16.5	27.7	29.4	51.1	6.9	76.6	23.4
	936	55.9	6.4	24.7	36.6	56.0	10.7	76.1	23.9
	287	17.2	5.2	52.6	34.1	73.2	26.5	88.2	11.8
1,673		100.0	10.9	30.1	33.9	56.7	12.7	78.5	21.5

¹ Moldy, rotten, or immature tomatoes only.

² Since many tomatoes may have had more than one type of defect, the total percentage imperfect tomatoes does not represent an addition of the percentages under types of defects.

receiving tomatoes exclusively in lug boxes were found in an unsalable condition as compared with 12 percent of the tomatoes prepackaged in plants receiving tomatoes in the larger, jumble-packed containers.

Other factors not found significantly related to or associated with the quality and condition of the prepackaged tomatoes purchased in retail stores were (1) dating or code dating of the packages, (2) waste and spoilage losses in surveyed plants, (3) the efficiency of labor in those plants, (4) sales returns and allowances policies, and (5) brand identification.

It was not possible to evaluate the effect of numerous other factors that undoubtedly affect the quality and condition of tomatoes available for purchase by store patrons. These would include such factors as: (1) the different producing areas in which the tomatoes were grown; (2) conditions under which the tomatoes were grown; (3) the variety of the tomatoes purchased; (4) methods and conditions of shipment, point to terminal point and of prepackaged tomatoes from prepackaging plant to retail food store; (5) ripening practices used in prepackaging plants; and (6) handling and merchandising practices employed in retail stores.



